Agnew & Sims

Tests on Coefficient of Elasticity of Plain Concrete In Compression and Encased Steel in Tension

Civil Engineering
B. S.
1905

TESTS ON COEFFICIENT OF ELASTICITY
OF
PLAIN CONCRETE IN COMPRESSION
AND
ENCASED STEEL IN TENSION

BY

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AND
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THESIS

FOR

DEGREE OF BACHELOR OF SCIENCE
IN
CIVIL ENGINEERING

COLLEGE OF ENGINEERING

UNIVERSITY OF ILLINOIS

PRESENTED JUNE 1905

UNIVERSITY OF ILLINOIS

May 26, 1905

This is to certify that the following thesis prepared under the direction of Professor A. N. Talbot, Head of the Department of Municipal and Sanitary Engineering, by

RALPH AGNEW and CHARLES EDWARD SIMS

entitled TESTS ON COEFFICIENT OF ELASTICITY OF PLAIN CONCRETE IN COMPRESSION AND ENCASED STEEL IN TENSION

is accepted by me as fulfilling this part of the requirements for the Degree of Bachelor of Science in Civil Engineering

Ira O. Baker.

Head of Department of Civil Engineering

Tests on Coefficient of Elasticity
of
Plain Concrete in Compression
and
Encased Steel in Tension.

The object of the tests herein described is to obtain some information concerning the coefficient of elasticity of plain concrete in compression and encased steel in tension.

In Professor Merriman's "Text-book on the Mechanics of Materials", the coefficient of elasticity is defined as "the ratio of the unit-stress to the unit deformation, provided the elastic limit of the material be not exceeded." This definition, however, cannot be made to apply to concrete in compression since the ratio of the unit-stress to the unit deformation within the elastic limit is not a constant factor.

There are three general methods employed in computing the coefficient of elasticity for plain concrete, which may be called, (1) the secant method, (2) the tangent method,

(3) the method using the elastic deformation. By the secant method a factor is obtained by which to multiply the deformation to obtain the stress. This method will be employed in this thesis, as the value thus obtained is in a form serviceable for use in computations of stresses in concrete beams. By the tangent method, the coefficient of elasticity expresses the rate at which the stress increases at a particular point. By the third method the coefficient of elasticity expresses the ratio of the stress to the elastic-deformation. It is not the purpose to enter into a discussion of the relative merits of these methods.

It is commonly assumed without experimental proof, that the ratio of the unit-stress to the unit-deformation in encased steel in tension is a constant up to the elastic limit of the steel,— a point which will be investigated with varying percentages of encasement and at varying ages of concrete.

The plain concrete is tested at

varying ages, varying proportions of materials, and by several methods of moulding.

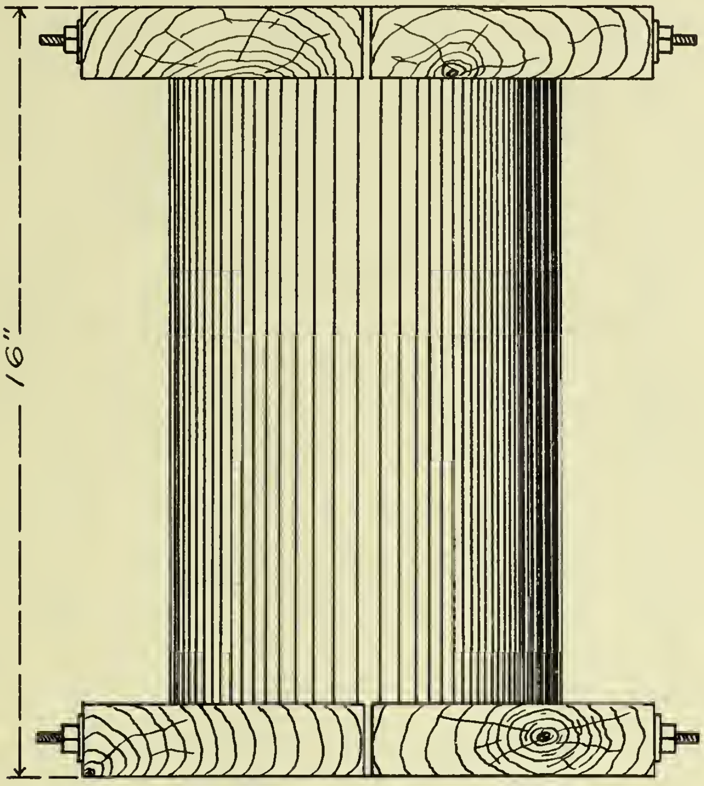
Description of Specimens.

Plain Concrete.

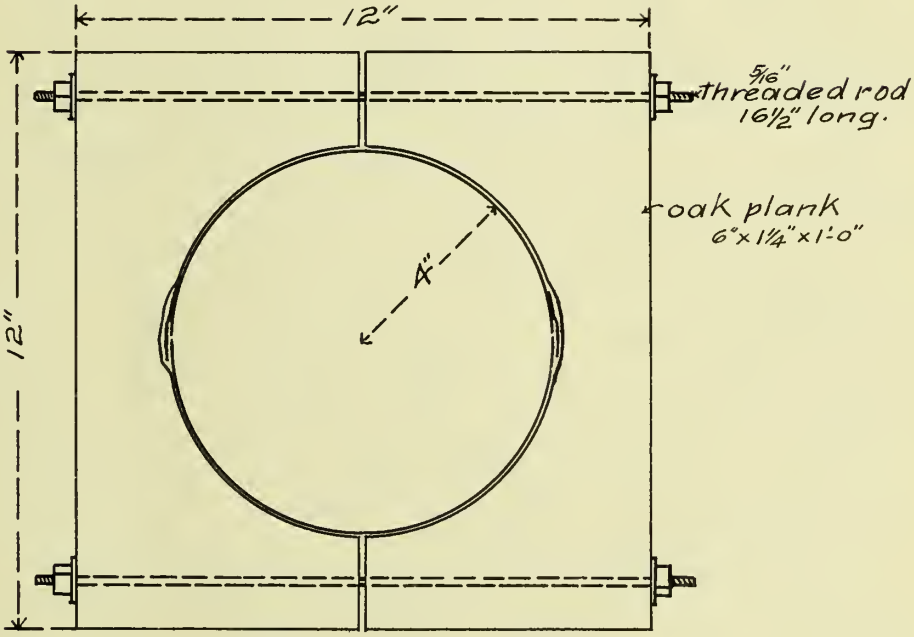
The tests to determine the coefficient of elasticity of concrete in compression were made on cylinders, eight inches in diameter and sixteen inches long. This proportion of length to diameter was made after consideration of the tests of specimens described on page 10, "University of Illinois Bulletin, Vol. II, No. 1, Tests of Reinforced Concrete Beams;" by Professor A. N. Talbot.

The specimens were made in groups of three. Of these only two from each group were to be tested if the results of the two tests agreed, otherwise the three were to be tested. The specimens were made in forms as shown in figure 1. While the cylinders thus formed were uniform in section throughout their length, yet the diameter of the specimens at any section in many cases varied ±0.08 inch from the diameter taken at right angles to the first. These

FORM FOR MOULDING CONCRETE CYLINDER.



ELEVATION.



PLAN

Figure 1.

conditions could have been avoided had the form used been made of two half-cylinders of cast-iron fastened along two elements of the cylinder by bolts or other suitable devise. With the form used some difficulty was met with in keeping the ends perpendicular to the axis of the cylinder, a difficulty which could have been avoided by using the cast-iron form above described. With light-weight galvanized sides as used, the forms could not be made sufficiently rigid while the tamping was being done. Also the joints were not water-tight, thus some of the cement, particularly in the first specimens made, was carried out.

The first six specimens made had uneven, porous surfaces, which was remedied in the remaining specimens by working a small trowel up and down in the concrete around the outside of the specimen while the material was being tamped.

The description of each set of specimens, and the age at which they were to be tested is given in table 1.

TABLE 1.

PLAIN CONCRETE SPECIMENS.

Number Made.	Age Days	Description	Proportions
3	30	Unscreened sand	1:3:6
3	15	Screened sand	1:3:6
3	30	" "	1:3:6
3	60	" "	1:3:6
3	60	" "	1:3:6
3	60	" "	1:2:4
3	60	6 inch cubes	1:3:6
3	60	" "	1:2:4

Encased Steel.

The tests to determine the coefficient of elasticity of encased steel were made upon 3/4 inch steel rods embedded in concrete cylinders, as shown by figure 2. Two kinds of steel were used, one so-called 'high steel' having an elastic limit of 51000 pounds per square inch, and the other having an elastic limit of 34000 pounds per square inch. The rods were encased in 1:3:6 concrete for a length

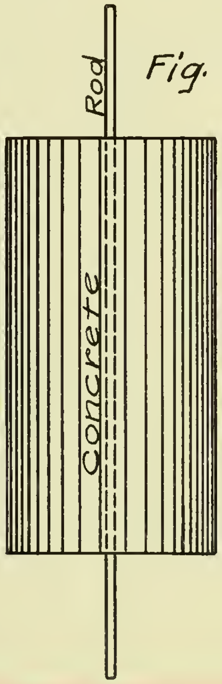


Fig. 2.

eight inches or sixteen inches to show the effect of different lengths of encasement. The cylinders were either eight inches or four inches in diameter to show the effect of varying thickness of encasement.

The description of the specimens made is given in table II.

TABLE II.

ENCASED-STEEL SPECIMENS.

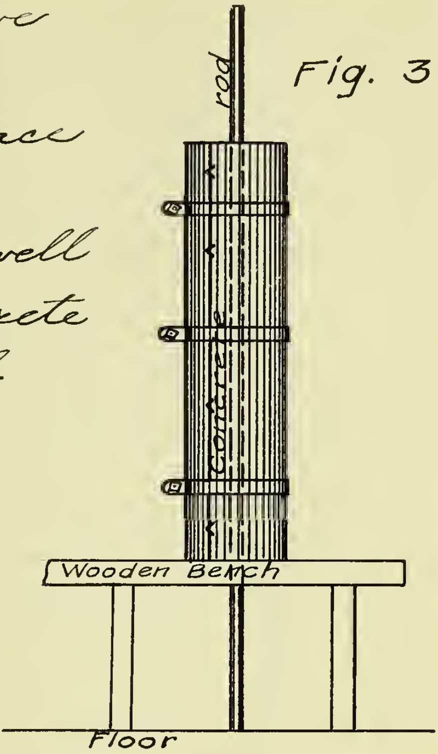
Number Made	Age Days	Description	Proportions.
3	30	Steel, 34000 E.L. Concrete 8"d., 16"l.	1:3:6
3	60	" , 51000 El. " 8" " , 16" "	1:3:6
3	60	" " " " 8" " , 8" "	1:3:6
3	60	" " " " 4" " , 16" "	1:3:6
Each rod was 12" longer than the concrete cylinder.			

The specimens, except those which were four inches in diameter, were molded in the forms used for the specimens of plain concrete, the forms being placed on a wooden bench through which a 3/4" hole was bored for each specimen to permit the rod of steel to extend six inches below the end of the concrete cylinder.

The cylinders 4" diameter and 16" long were made in forms of sheet iron with edges overlapping, and held together by three bands of strap-

iron fastened by bolts as shown in figure 3. This gave good results.

Fig. 3.



The inner surface of each form for encased steel as well as for plain concrete was well cleaned and oiled before using.

Mixing the Concrete.

For the details involved in mixing the concrete reference is made to the thesis by Mr. E. T. Renner, entitled, "Tests of Reinforced Concrete Beams — Effect of Release of Load," presented June, 1905. The concrete was tamped in the form in layers about three inches in depth with an iron tamper having a cross-section of 3"×3", and weighing ten pounds.

Storing.

After the concrete had set for forty-eight hours, the forms were

taken off, and the specimens stored, until time of testing, in the air in a room in which the temperature was nearly constant at seventy degree's Fahrenheit.

Details of Tests.

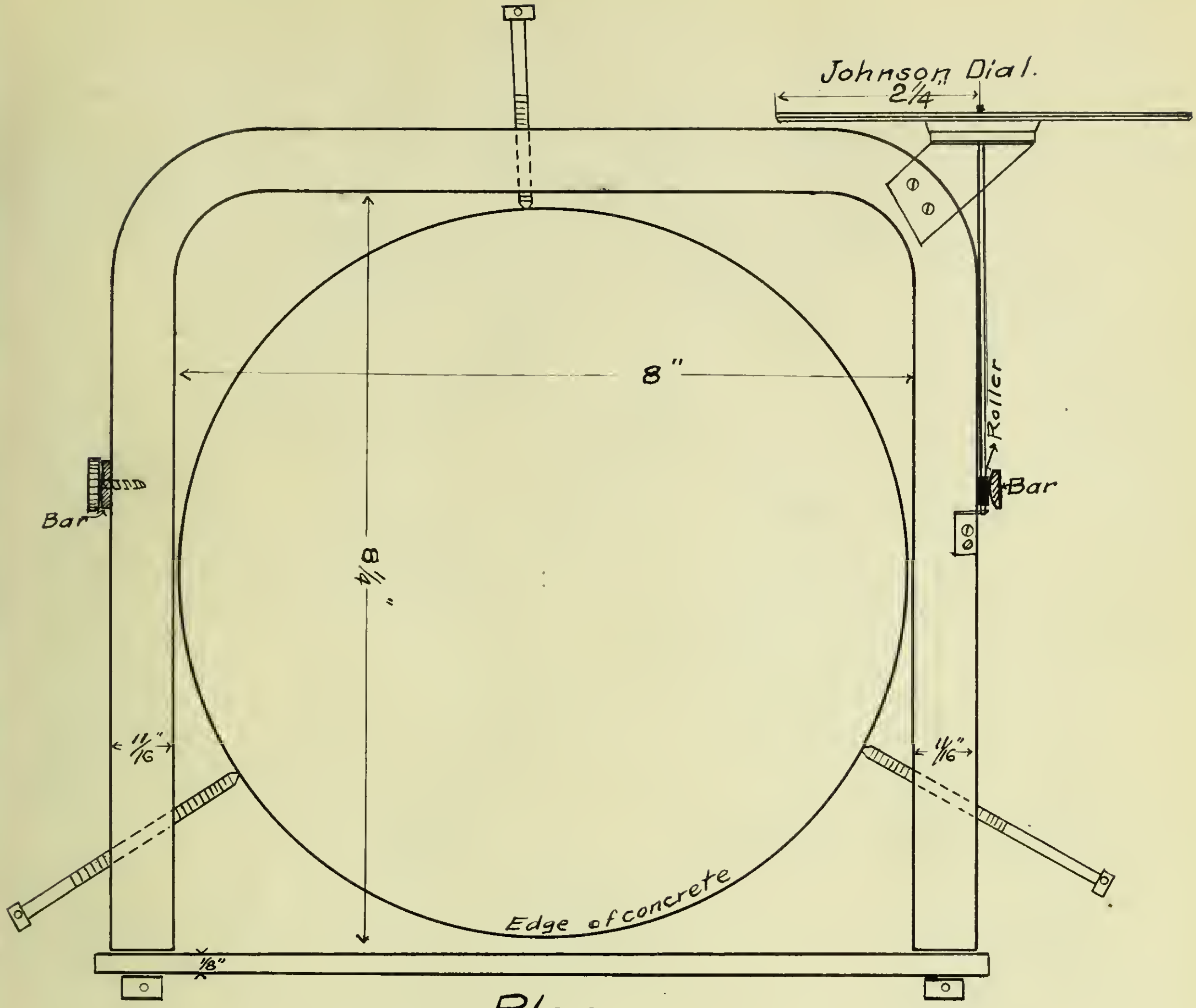
The machines used were the 100000 pound capacity Philadelphia, or Falkenau and Sinclair, and the 100000 pound capacity Riehle, the tension tests being made solely on the latter machine. In every case the slowest speed of the machine was used (the hand wheel on Riehle not considered).

It was necessary to determine the best method of testing the plain concrete specimens. A spherical bearing block was not tried as eccentric loading had developed from its use in previous experiments. With specimen 22 the load was applied through two steel rollers placed at right angles and centered over the axis of the piece, but difficulty was experienced in very accurately centering the rollers and better results were obtained through the use of fixed steel bearing blocks. The specimens in

every instance were coated on the ends with thin layers of plaster of paris under a pressure of thirty to sixty pounds per square inch, thus making the ends in parallel planes and distributing the load uniformly.

The load was applied in increments of one thousand to three thousand pounds, no great care being taken to secure equal increments. The load was applied until it was evident that the maximum had been passed and the manner of failure plainly indicated.

The extensometer used for the compression tests to measure the deformations consisted of two yokes upon each of which was mounted a Johnson dial graduated to one ten-thousandth of an inch. The yokes were placed twelve inches apart, centre to centre, in most instances. For the tension tests two special yokes were made, upon one of which was mounted two Johnson dials. Each of these extensometer frames were



Plan.

Elevation.

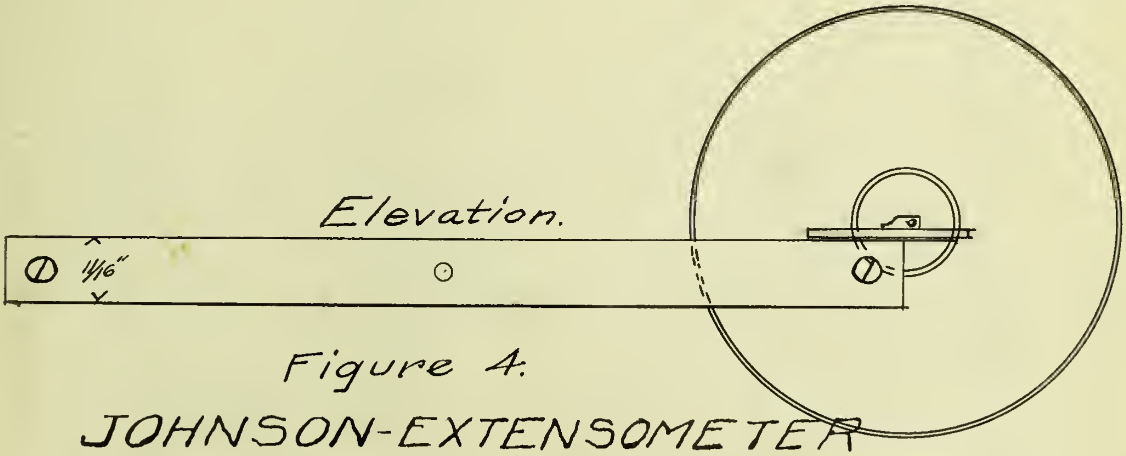


Figure 4.

JOHNSON-EXTENSOMETER
FOR
PLAIN-CONCRETE-TESTS.
scale 1"=2"

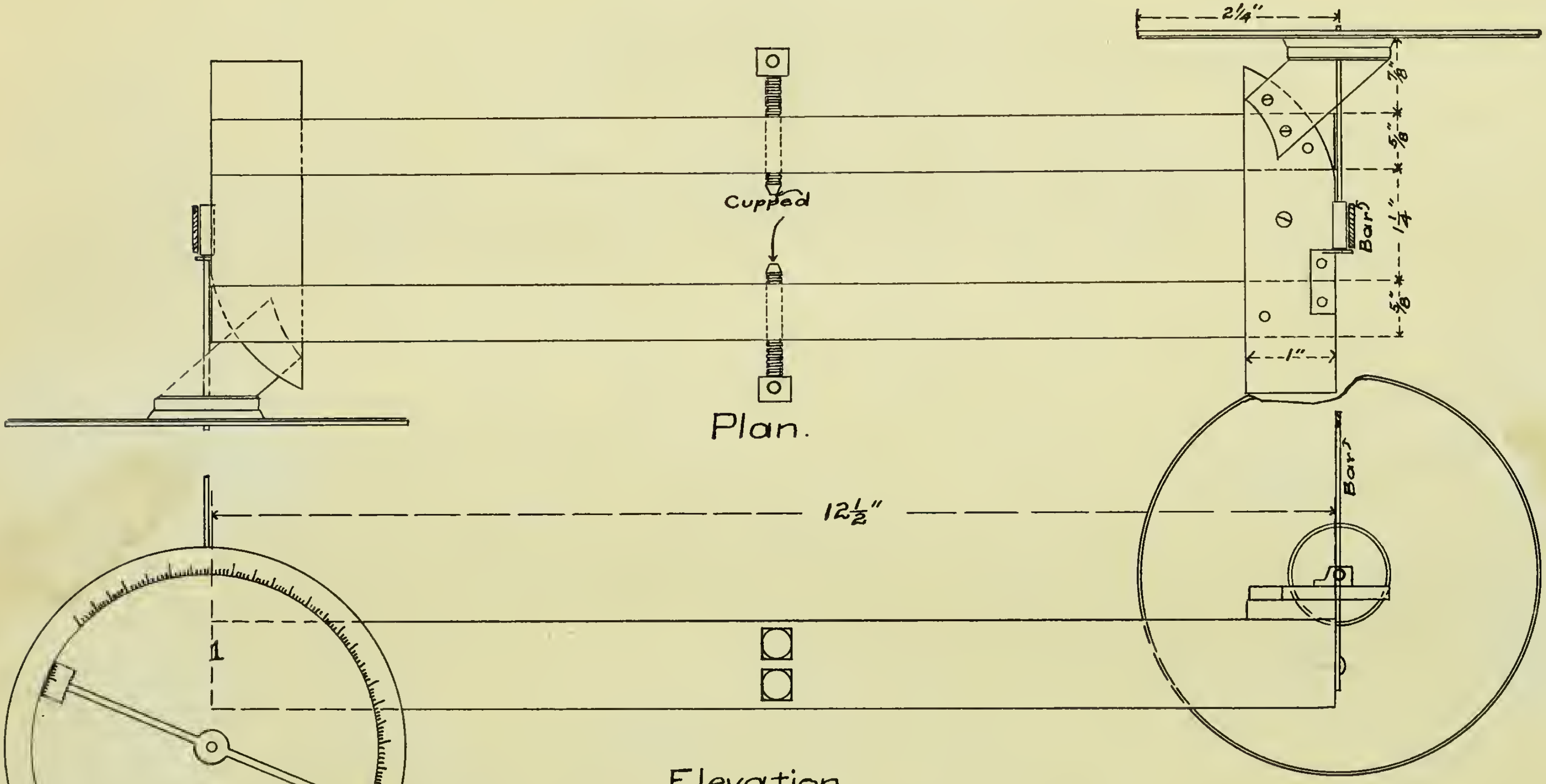


Fig. 5.

Material:-

Two steel bars, 1"×⅝"×12½"
" " " 1"×⅝"×1¼"
Four cupped screws, ¼"×1⅛"
Duplicate above material
for second extensometer, without dials.

EXTENSOMETER
FOR
ENCASED-STEEL TESTS.
Scale, 1 inch = 2 inches.

connected vertically by two bars on opposite sides or ends of the yokes, each fixed at one end to the yoke by set screws, and at the free end bearing upon the shaft which operated the arrow in the dial. The special yokes for the tension tests were made one and one-half inches in depth instead of one inch as shown by figure in order to provide for two cupped screws, but this additional metal made the yoke needlessly heavy although no error in the data obtained by their use can be attributed to this cause. It is recommended that, for new yokes, the cupped screws be made smaller in diameter to secure better proportions.

To avoid lost motion the roller bearing, the arrow in the dial at the beginning of each series of loads was turned in the direction opposite to that in which it moved under the load next applied.

In the compression tests the extensometer yokes were taken off as soon as the concrete bulged, so

as not to strain the yokes. See figures 5, 4.

In the tension tests the gage length was seventeen to eighteen inches, just enough to clear the concrete. It was necessary, after having passed the elastic limit of the rod to tighten up the bearing screws, in which case it was necessary to reset the arrows in the dials to the reading obtained before the screws were tightened.

The rod was gripped as close to the extensometers as could be and a small initial load put on to insure the grip.

The photograph, figure 6, gives a clear view of the setting of the specimen of plain concrete, and shows the extensometer apparatus used.

TEST OF PLAIN CONCRETE.

Figure 6.

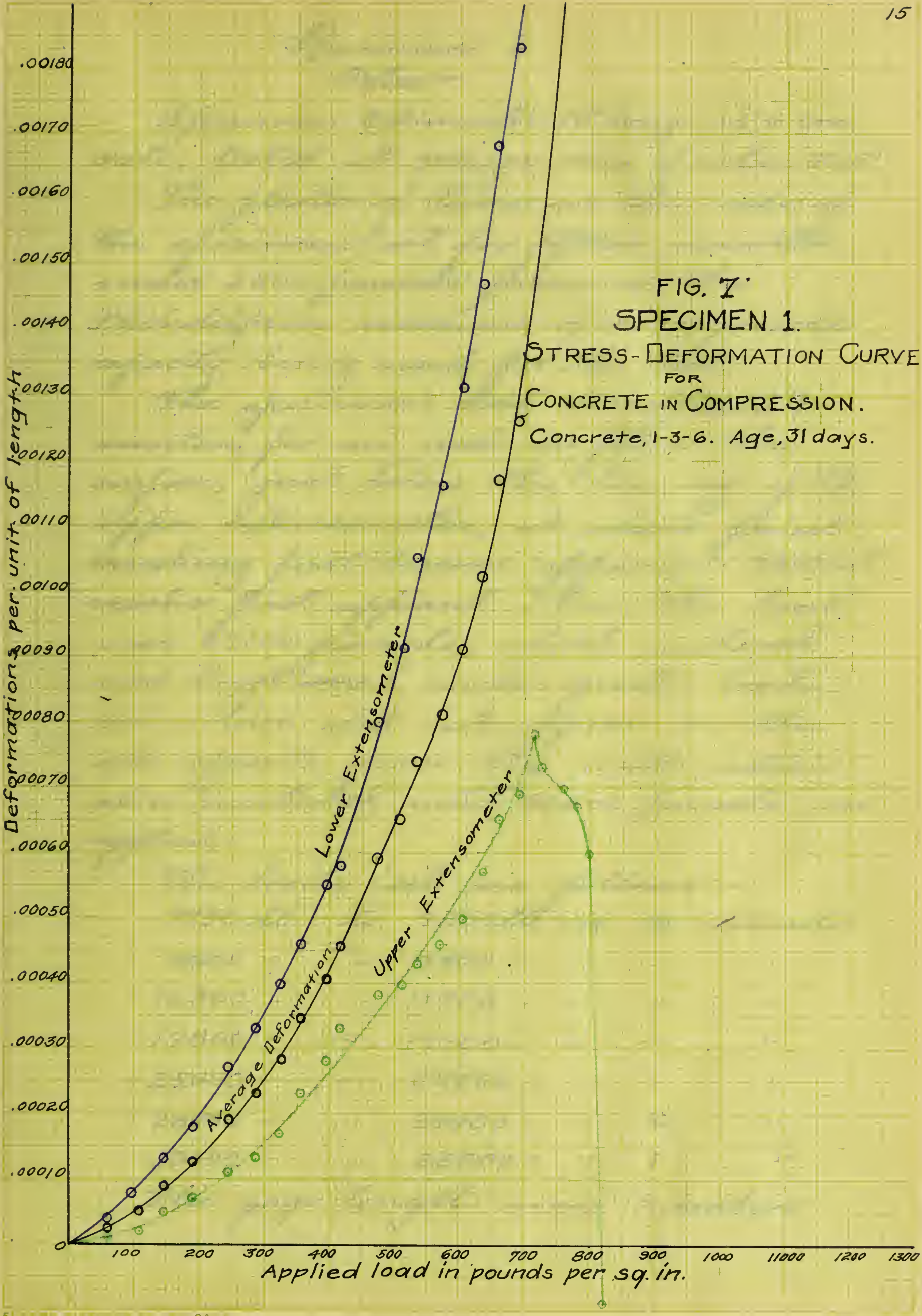


FIG. 7.
SPECIMEN 1.
STRESS-DEFORMATION CURVE
FOR
CONCRETE IN COMPRESSION.
Concrete, 1-3-6. Age, 31 days.

Specimen 1.

Notes:-

Specimen 8" diameter, 16" long, 1:3:6 concrete, tested at 31 days. Area of section 50.25□"

The plaster of Paris on the ends of the specimen set for fifteen minutes under 2500 pounds pressure, the Philadelphia machine of 100000 pounds capacity being used for the test.

The specimen had insufficient mortar, for an inch in from the surface, just below the bearing of the upper extensometer, at which point crushing first became apparent. Vertical cracks first appeared when the load was 27100 pounds, which widened and lengthened under greater loads, but which did not appear on the side opposite from the weak section above mentioned until 30400 pounds were applied.

The loads 'set' as follows:-

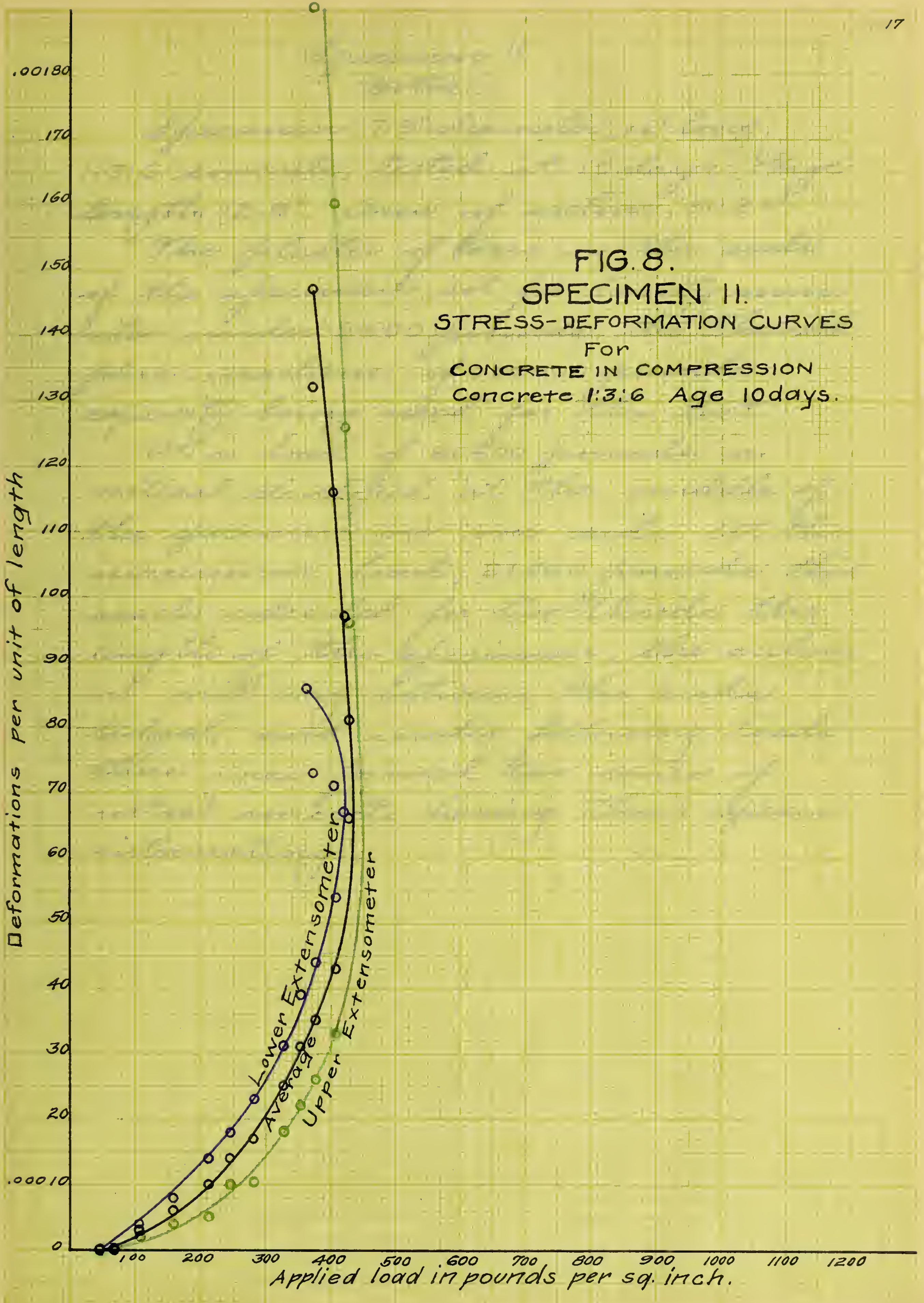
7750 lb.	to	7500 lb.	in	½	minute.
9600 "	"	9300 "	"	"	"
12300 "	"	11700 "	"	"	"
17800 "	"	17100 "	"	"	"
25600 "	"	25000 "	"	"	"
28700 "	"	24700 "	"	2	"
30400 "	"	28400 "	"	1	"

The gage length was 12 inches.

FIG. 8.

SPECIMEN 11.

STRESS-DEFORMATION CURVES
For
CONCRETE IN COMPRESSION
Concrete 1:3:6 Age 10 days.



Specimen 11.

Notes:-

Specimen 7.9" diameter, 16" long, 1:3:6 concrete, tested at 10 days. Gage length 12.9". Area of section, 50.2 □"

The plaster of Paris on the ends of the specimen set for twenty minutes under 2500 pounds, the Philadelphia machine of 100000 pounds capacity being used for the test.

At a load of 20500 pounds a vertical developed at the middle of the specimen on one side. At the maximum load, 21500 pounds, this cracks extended for two-thirds the length of the specimen, the section at mid-way between the ends bulged, and under following loads there were formed two cones of intact concrete having their apexes intersecting.

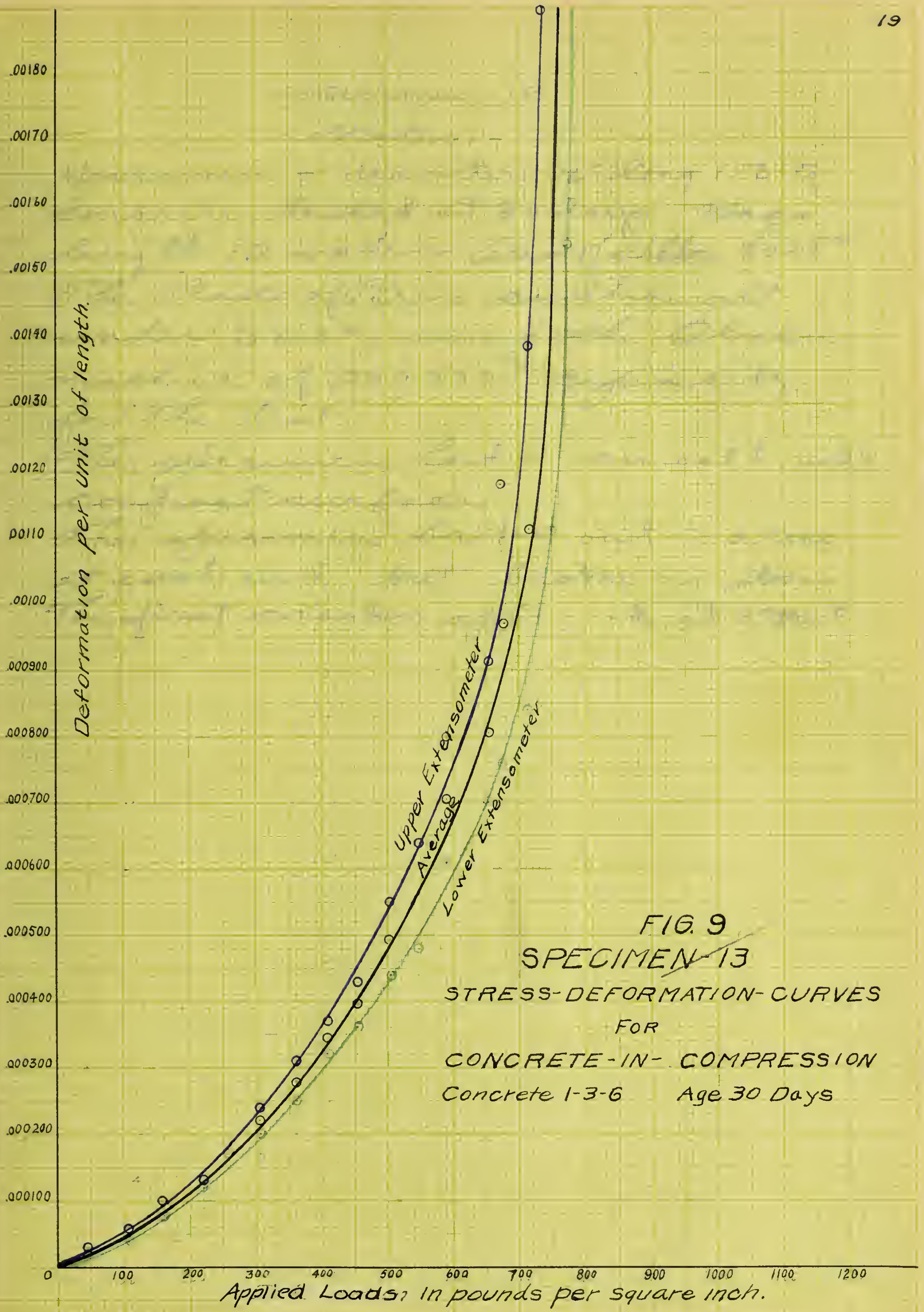


FIG. 9
SPECIMEN 13
STRESS-DEFORMATION-CURVES
FOR
CONCRETE-IN-COMPRESSION
Concrete 1-3-6 Age 30 Days

Specimen 13

Notes:-

Specimen 8" diameter, 16" long 1:3:6 concrete, tested at 30 days. Gage length 12 inches. Area of section 50.25□".
The Plaster of Paris cushion set under 3800#, using the Olsen machine of 200000# capacity for the test.
The specimen had a smooth, well compact surface.
The specimen broke out to a cone at each end, but broke no stones.
The first cracks appeared at 37800#.

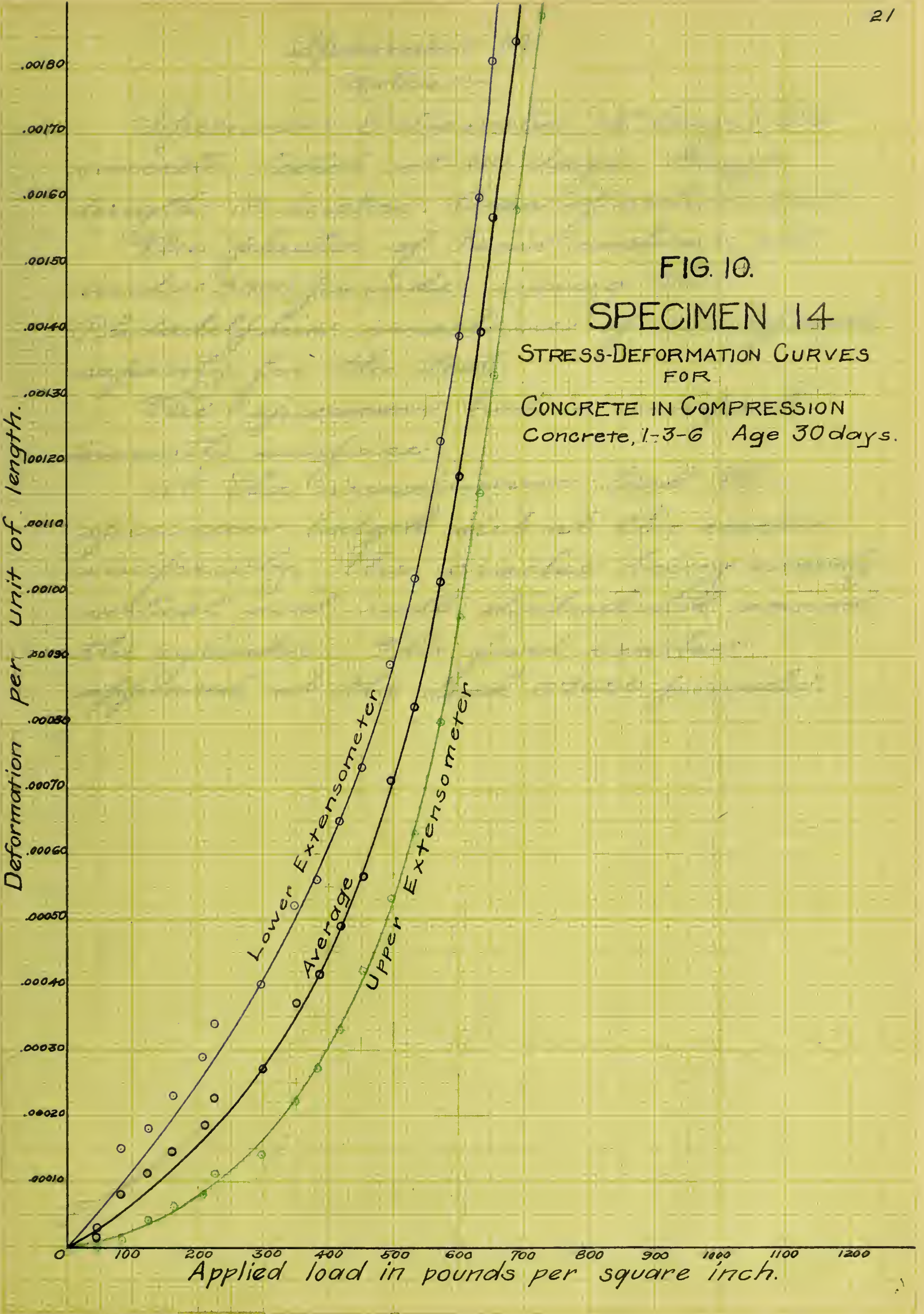


FIG. 10.

SPECIMEN 14

STRESS-DEFORMATION CURVES
FOR
CONCRETE IN COMPRESSION
Concrete, 1-3-6 Age 30 days.

Specimen 14.

Notes:-

Specimen 8" diameter, 16" long, 1:3:6 concrete, tested at 60 days. Gage length 12 inches. Area of section 50.25□"

The plaster of Paris cushion set under 3500 pounds, using the Philadelphia machine of 100000 pounds capacity for the test.

The specimen had a compact, smooth surface.

At the maximum load the specimen bulged out at the centre uniformly, the cracks being mainly vertical and well distributed around the cylinder. The first cracks appeared at the load 37600 pounds.

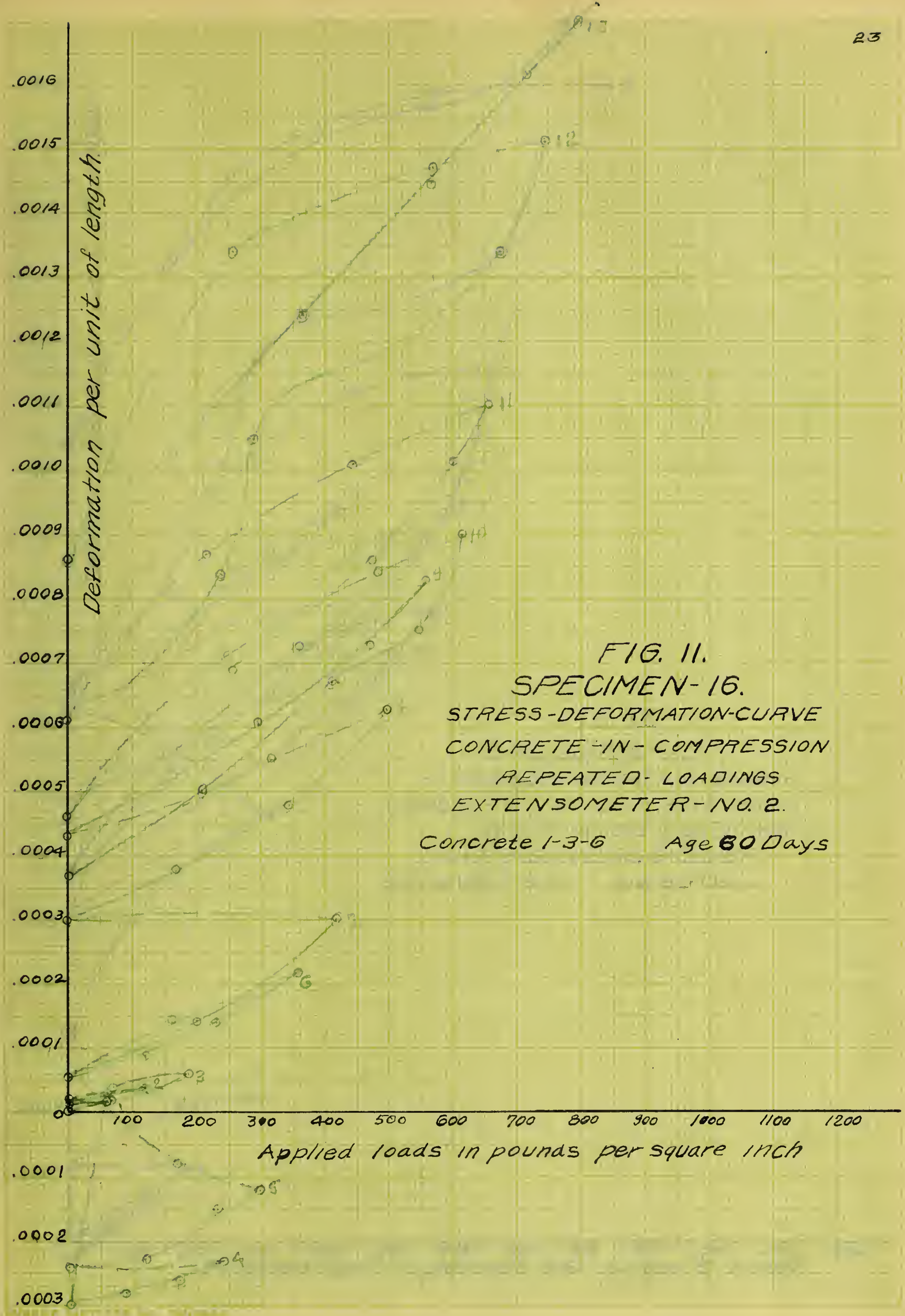


FIG. 11.
SPECIMEN-16.
STRESS-DEFORMATION-CURVE
CONCRETE-IN-COMPRESSION
REPEATED-LOADINGS
EXTENSOMETER-NO. 2.
Concrete 1-3-6 Age 60 Days

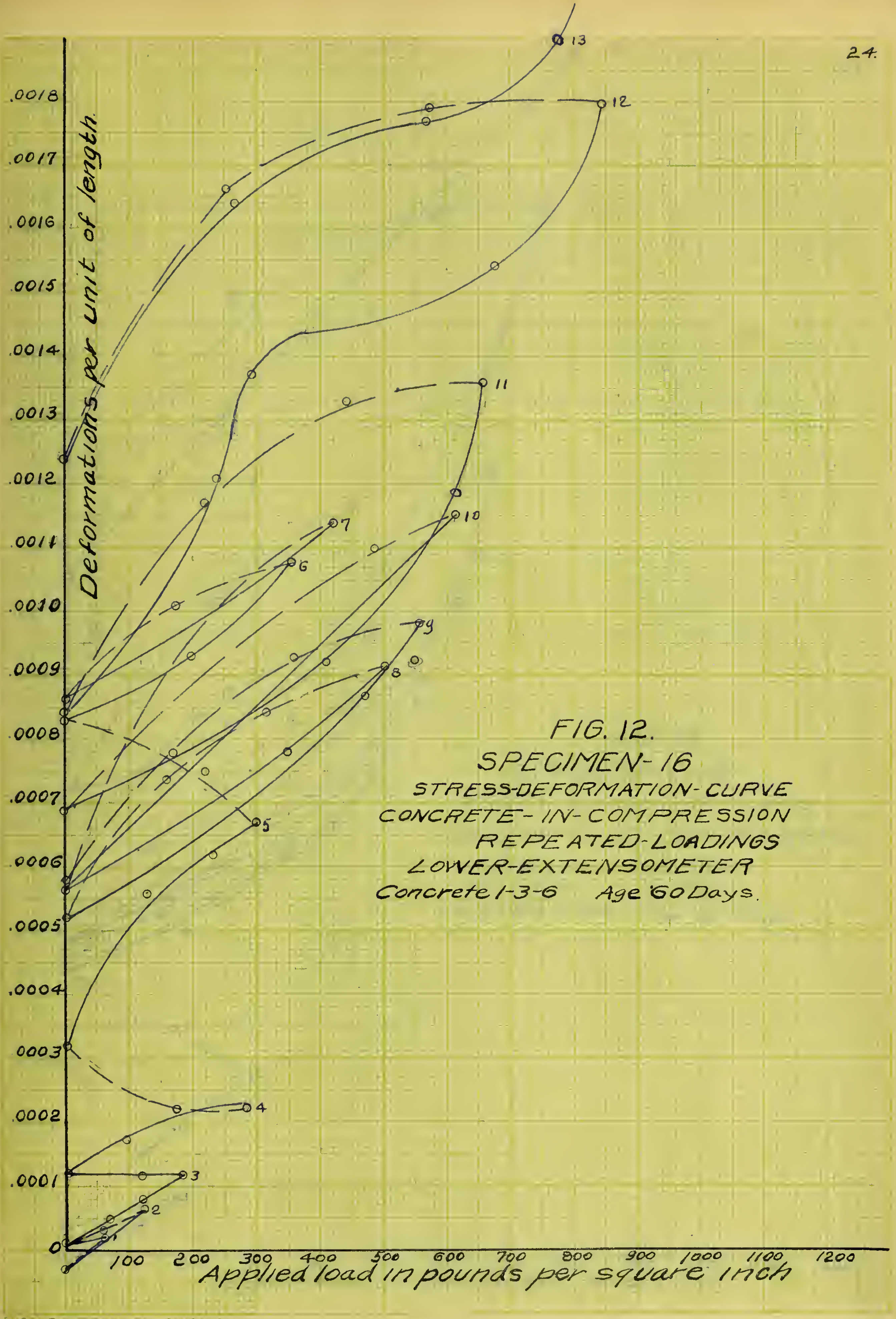


FIG. 12.
SPECIMEN-16
STRESS-DEFORMATION-CURVE
CONCRETE-IN-COMPRESSION
REPEATED-LOADINGS
LOWER-EXTENSOMETER
Concrete 1-3-6 Age 60 Days.

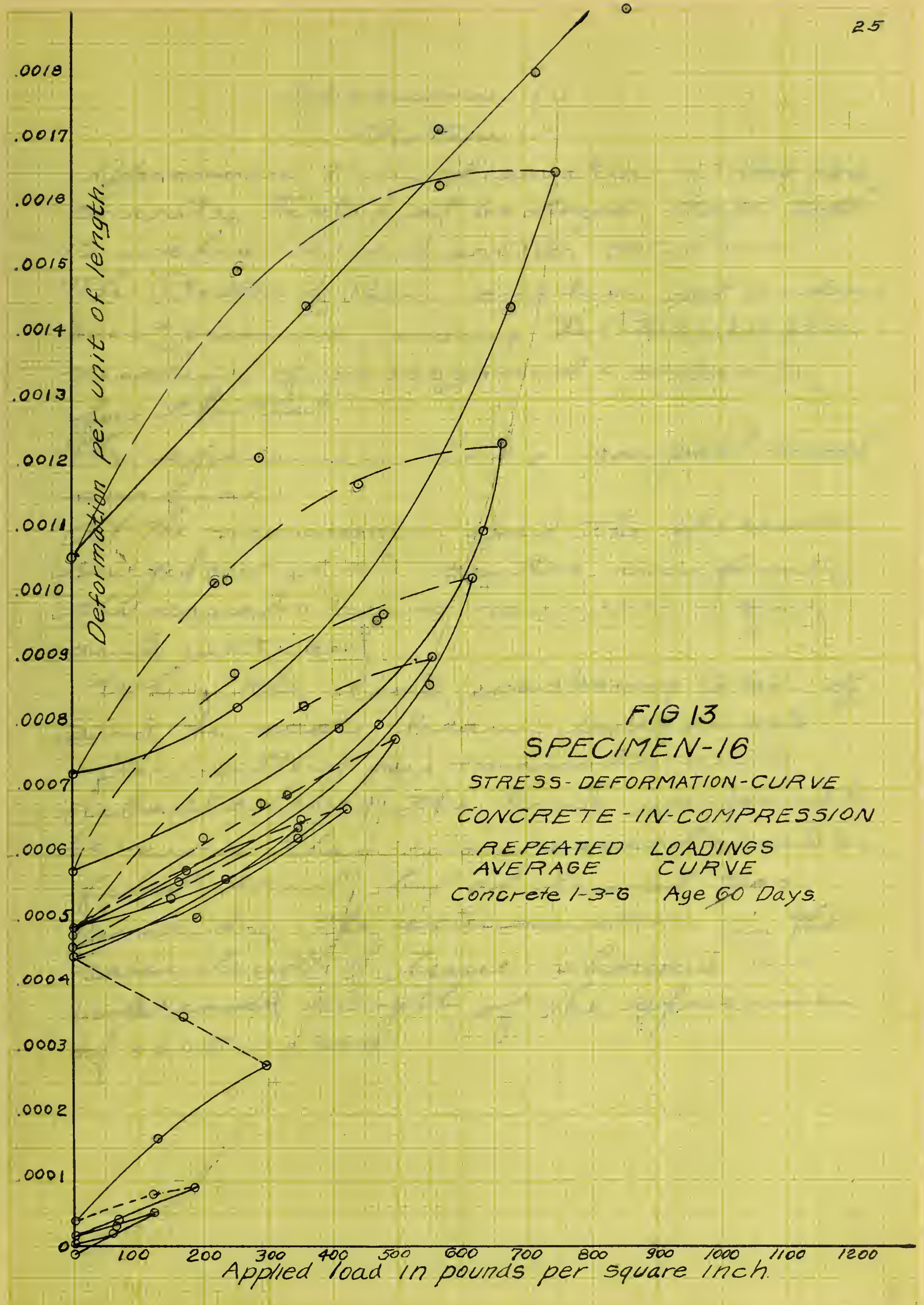


FIG 13

SPECIMEN-16

STRESS-DEFORMATION-CURVE

CONCRETE-IN-COMPRESSION

REPEATED LOADINGS
AVERAGE CURVE

Concrete 1-3-6 Age 60 Days

Specimen 16

Notes:-

Specimen 8" in diameter 16" long. 1-3-6 concrete, tested at 60 days. Gage length 12 inches. Area of section 50.25 sq. in.. The Plaster of Paris cushion set under 6000# pressure, using the Philadelphia machine of 100 000 pounds capacity for the test.

The specimen had a compact smooth surface.

At the maximum load, the specimen bulged out at the centre uniformly, the cracks being numerous, fine and vertical.

When the load was being taken off and the scale beam ballanced, after setting one minute and reballancing the load was found to be more than was ascertained by first trial, by at least 200 pounds, the extensometers in the same length of time showed an increased length of the specimen of .0005 inches.

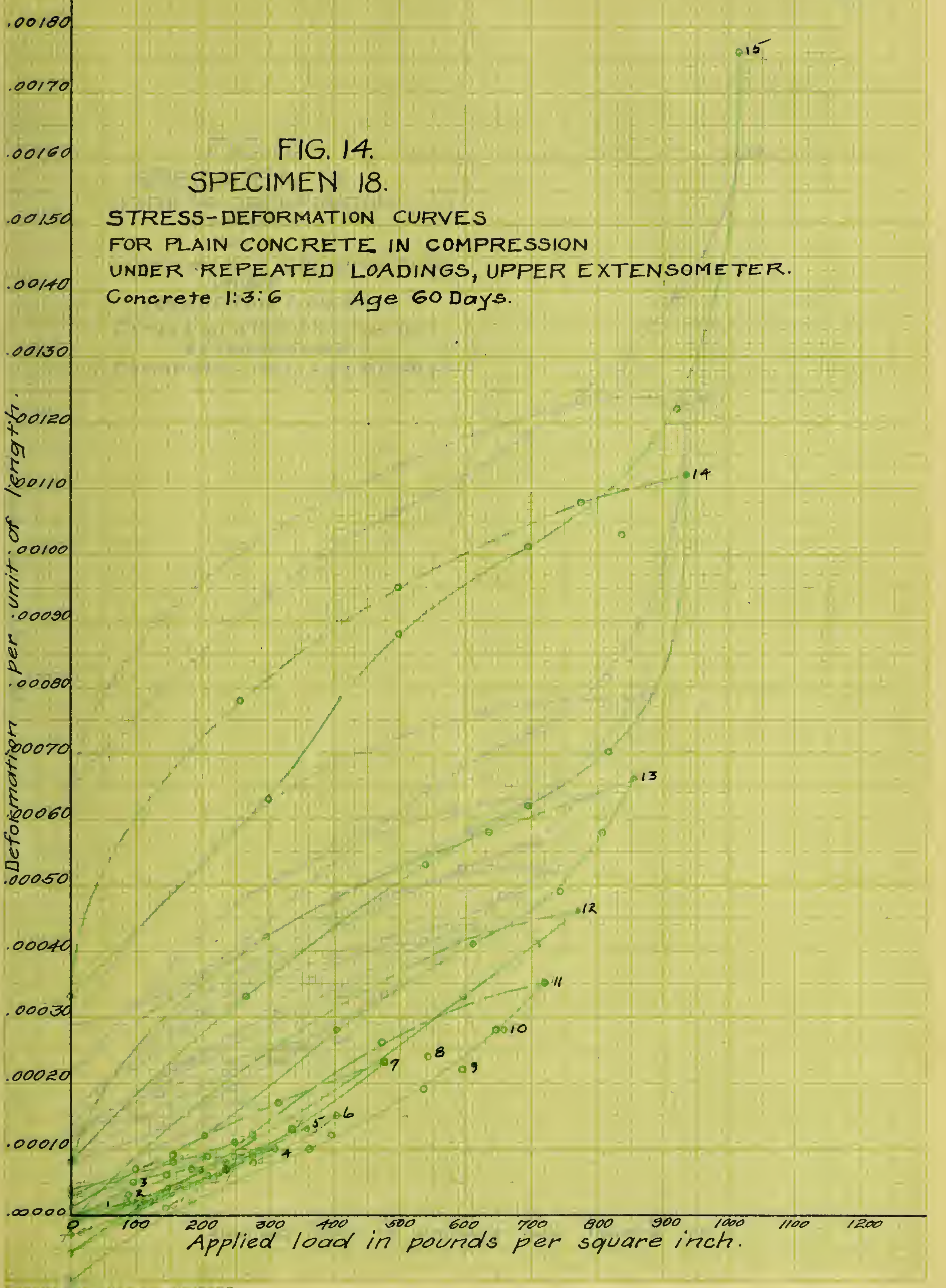


FIG. 14.
SPECIMEN 18.
STRESS-DEFORMATION CURVES
FOR PLAIN CONCRETE IN COMPRESSION
UNDER REPEATED LOADINGS, UPPER EXTENSOMETER.
Concrete 1:3:6 Age 60 Days.

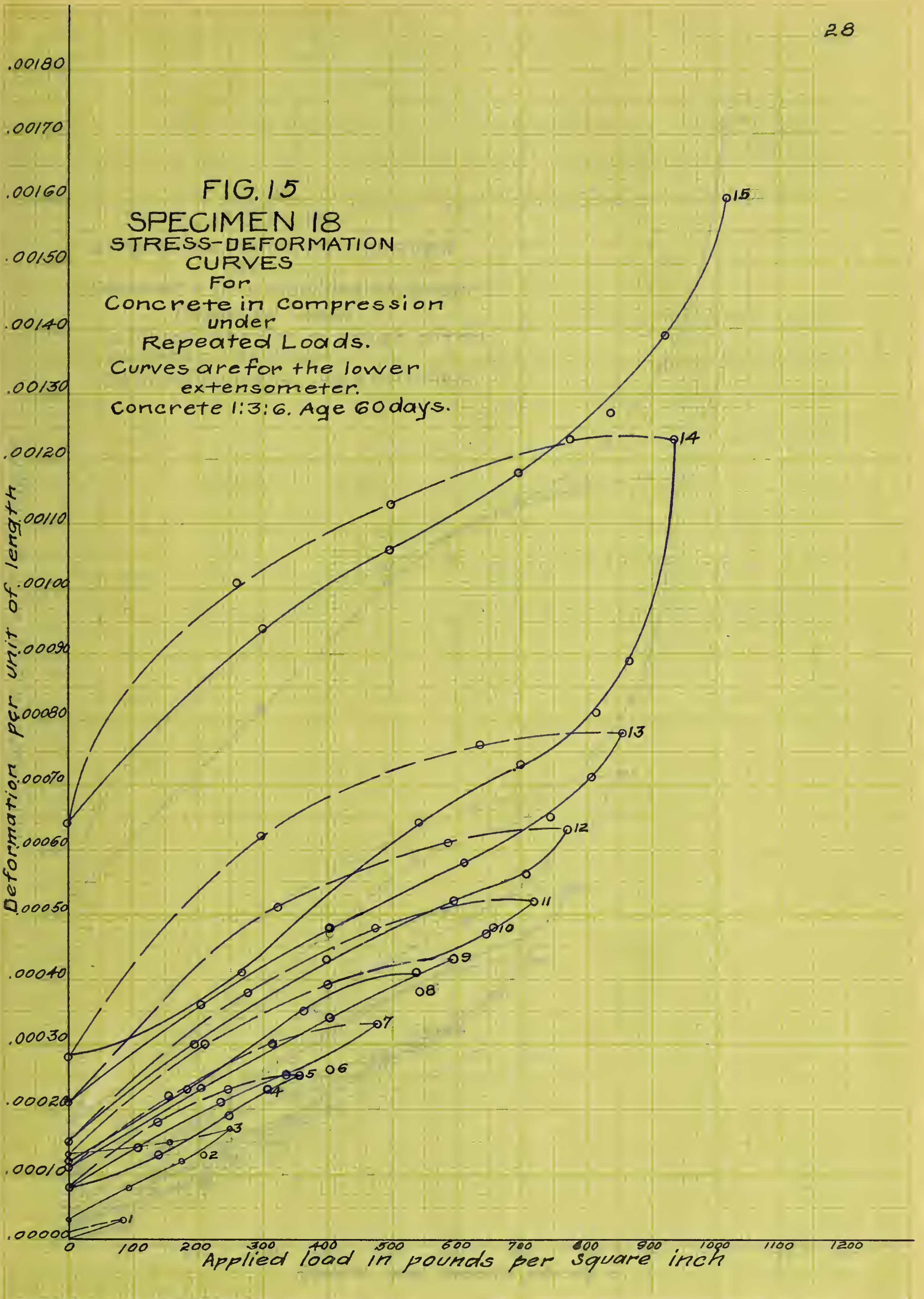


FIG. 15

SPECIMEN 18

STRESS-DEFORMATION CURVES For Concrete in compression under Repeated Loads.

Curves are for the lower extensometer.

Concrete 1:3:6. Age 60 days.

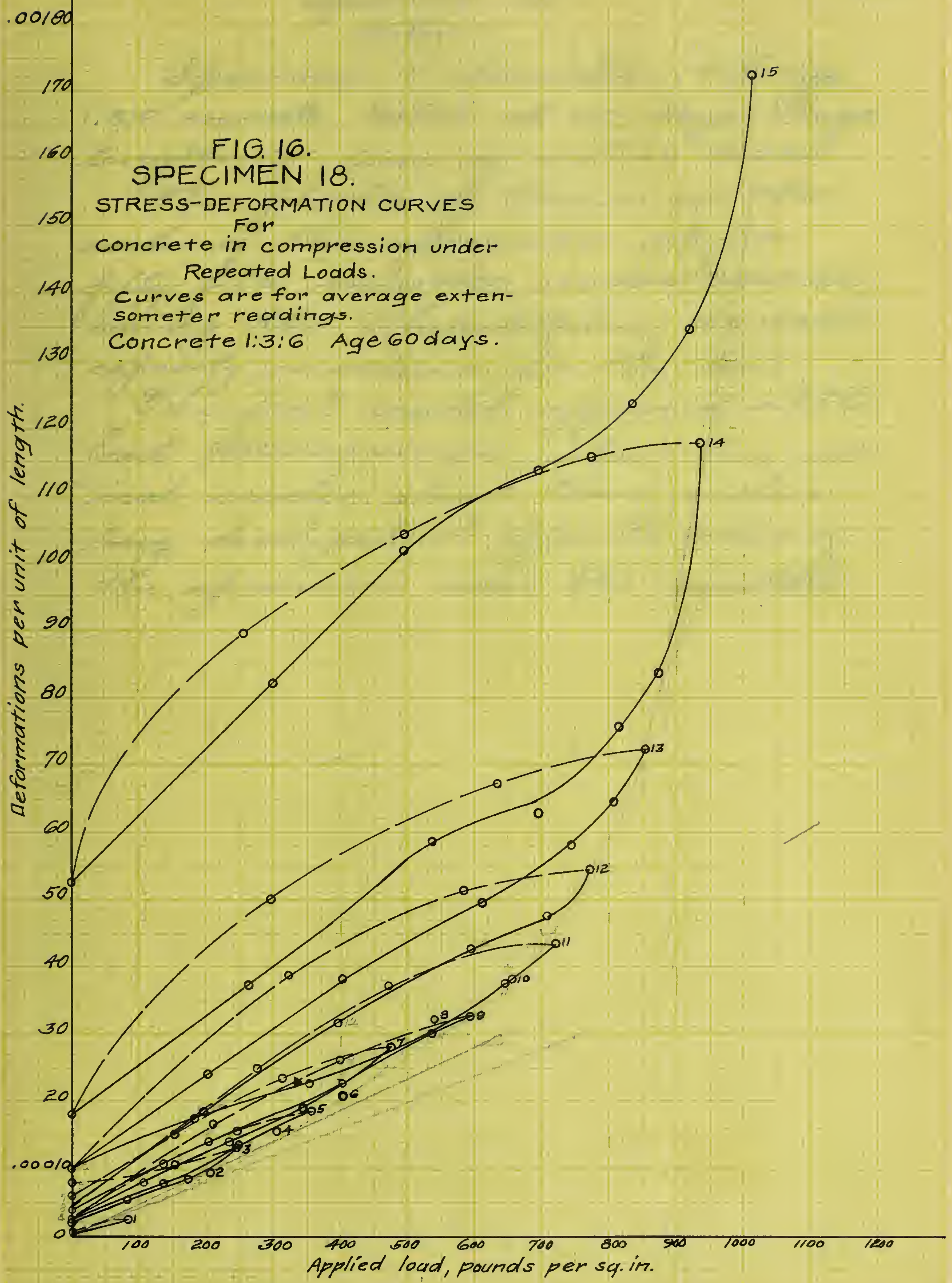


FIG. 16.
SPECIMEN 18.
STRESS-DEFORMATION CURVES
For
Concrete in compression under
Repeated Loads.
Curves are for average extensometer readings.
Concrete 1:3:6 Age 60 days.

Specimen 18.

Notes:-

Specimen 8" diameter, 16" long, 1:3:6 concrete, tested at 60 days. Gage length 12". Area of section 50.25□".

The plaster of Paris on the ends of the specimen set for fifty-five minutes under 3500 lb., using the Philadelphia 100000 lb. capacity machine for the test.

The first cracks appeared at the load 50000 pounds, when two vertical cracks about three inches long developed at opposite sides of the specimen near the middle.

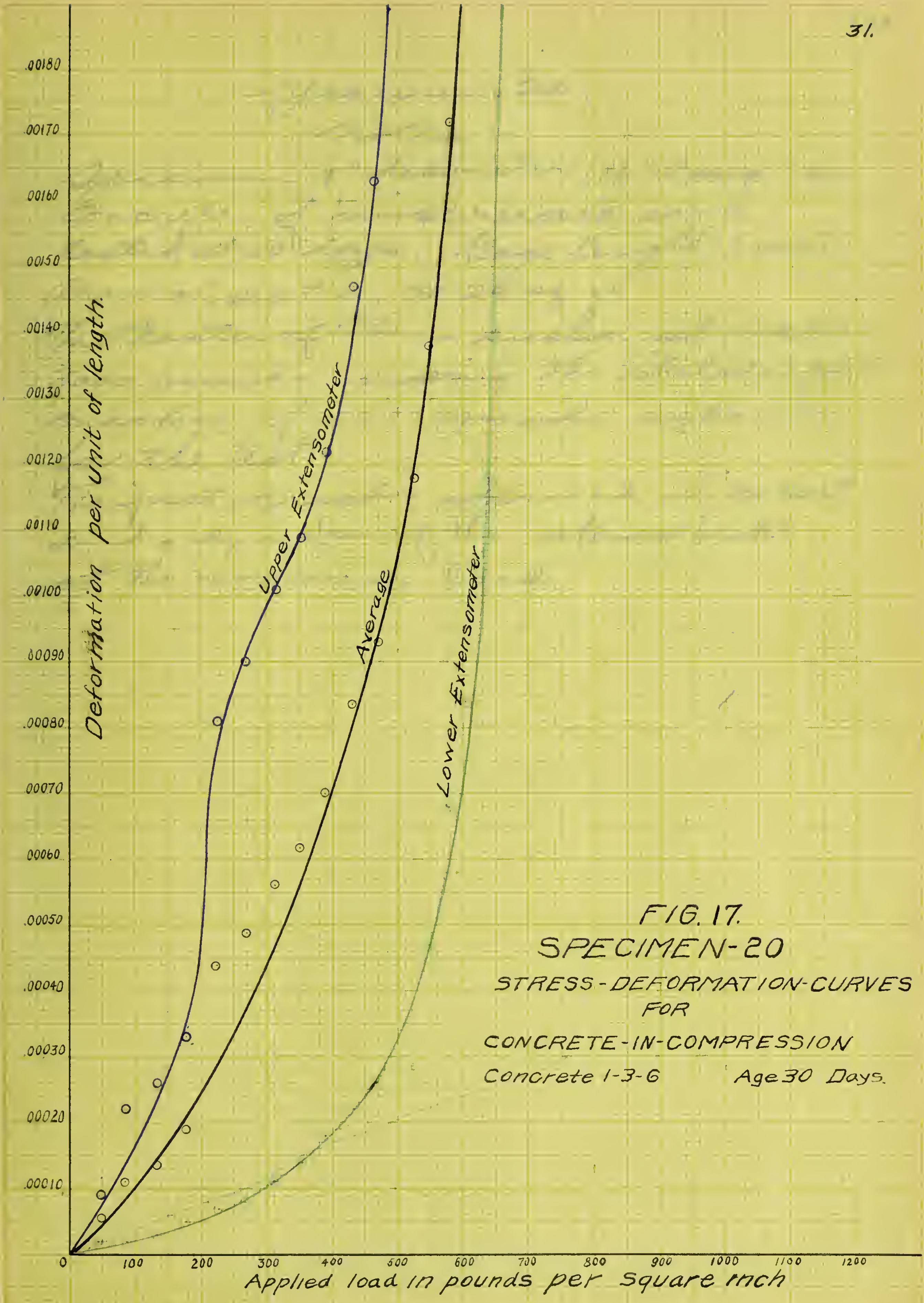


FIG. 17.

SPECIMEN-20

STRESS-DEFORMATION-CURVES
FOR
CONCRETE-IN-COMPRESSION

Concrete 1-3-6 Age 30 Days.

Specimen 20

Notes:-

Specimen 8" diameter, 16" long, 1:3:6 Concrete, of unscreened sand, tested at 60 days. Gage length 12 inches. Area of section 50.26 sq. in.

The Plaster of Paris cushion set under 3000 pounds, using the Philadelphia machine of 100 000 pounds capacity, for the test.

The first cracks appeared at 30 500#, and only a few of the stones broke at the maximum load.

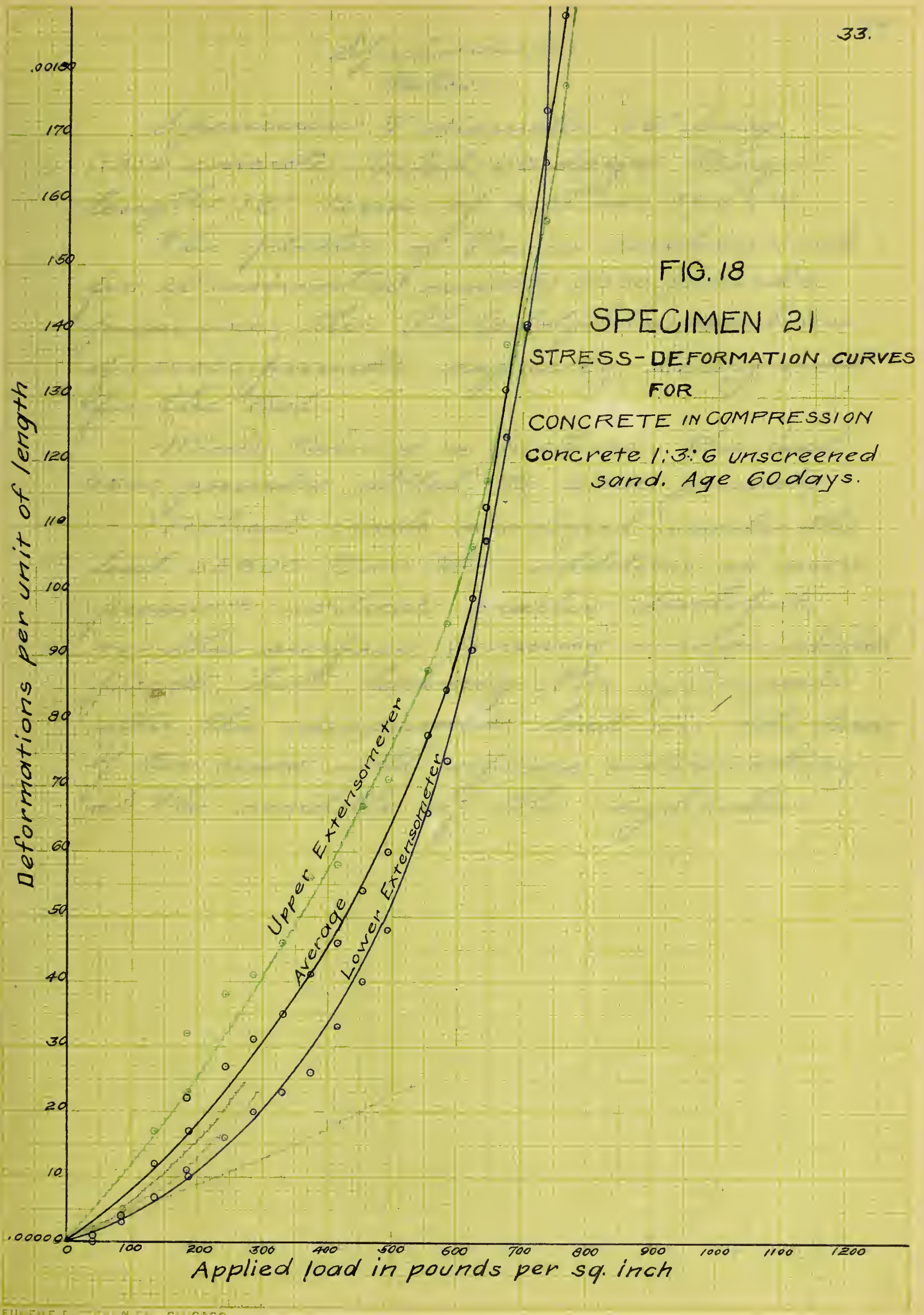


FIG. 18

SPECIMEN 21

STRESS-DEFORMATION CURVES
FOR
CONCRETE IN COMPRESSION

Concrete 1:3:6 unscreened
sand. Age 60 days.

Specimen 21.

Notes:-

Specimen 8" diameter, 16" long, 1:3:6 concrete, tested 60 days. Gage length 12". Area of section 50.25□"

The plaster of Paris cushion set for 20 minutes under 2000 pounds pressure, the Philadelphia machine of 100000 pounds capacity being used for the test.

While taking a picture, the load 9500 pounds settled to 9300 pounds.

Vertical cracks developed under the load 38300. On the addition of more pressure vertical cracks developed on the surface forming wedge shaped pieces, but leaving the specimen after the maximum load in the form of two cones with apexes intersecting at the middle of the cylinder.

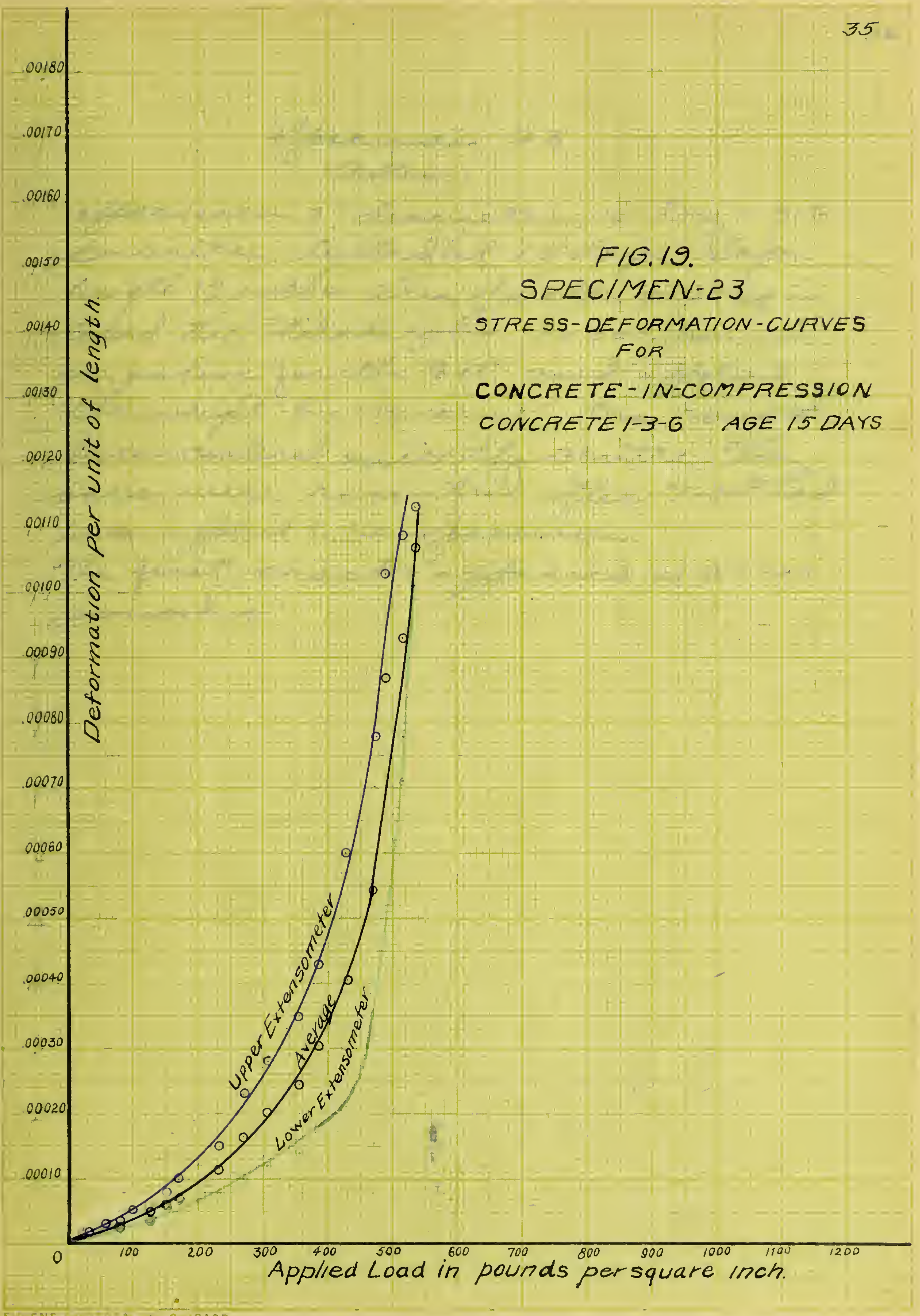


FIG. 19.
SPECIMEN-23
STRESS-DEFORMATION-CURVES
FOR
CONCRETE-IN-COMPRESSION
CONCRETE 1-3-6 AGE 15 DAYS

Specimen 23.

Notes:-

Specimen 8" diameter, 16" long, 1:3:6 concrete, tested at 15 days. Gage length 12 inches. Area of section 50.25 sq. in. Used the Philadelphia 100 000 pound machine for the test, and applied the weight by means of two round bars centered over the centre. The bars were recentred after 7600# had been applied to the specimen.

The first cracks appeared at 24700 pounds.

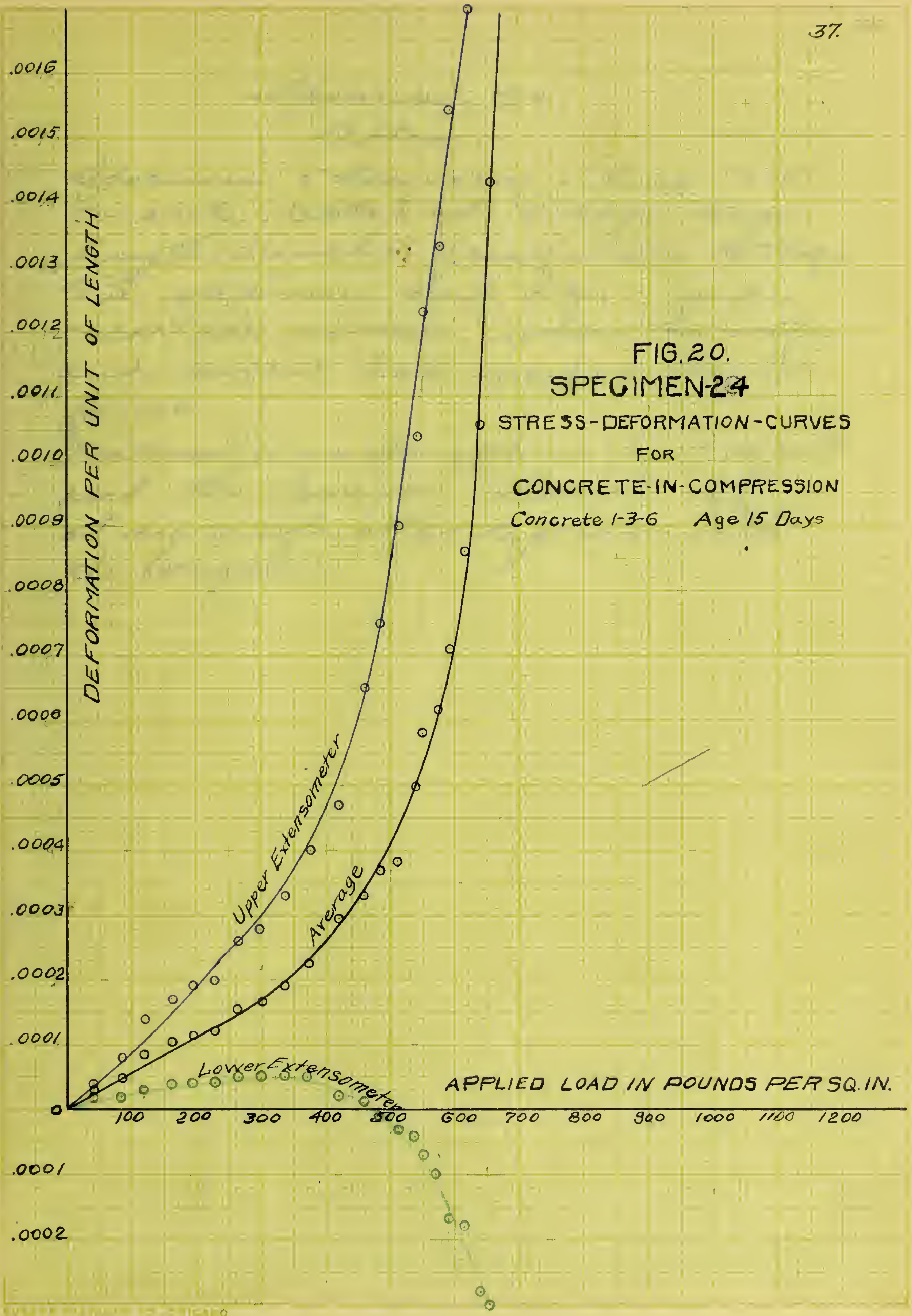


FIG. 20.
SPECIMEN-24
STRESS-DEFORMATION-CURVES
FOR
CONCRETE-IN-COMPRESSION
Concrete 1-3-6 Age 15 Days

Specimen 24.

Notes:-

Specimen 8" diameter, 16" long, 1:3:6 concrete, tested at 15 days. Gage length 12 inches. Area of section 50.25 sq.in. The specimen had a few voids near the bottom, where the water and cement had escaped from the forms.

Vertical cracks appeared at 88300# and the specimen "sheared off" at an angle of 60 degrees with the horizontal.

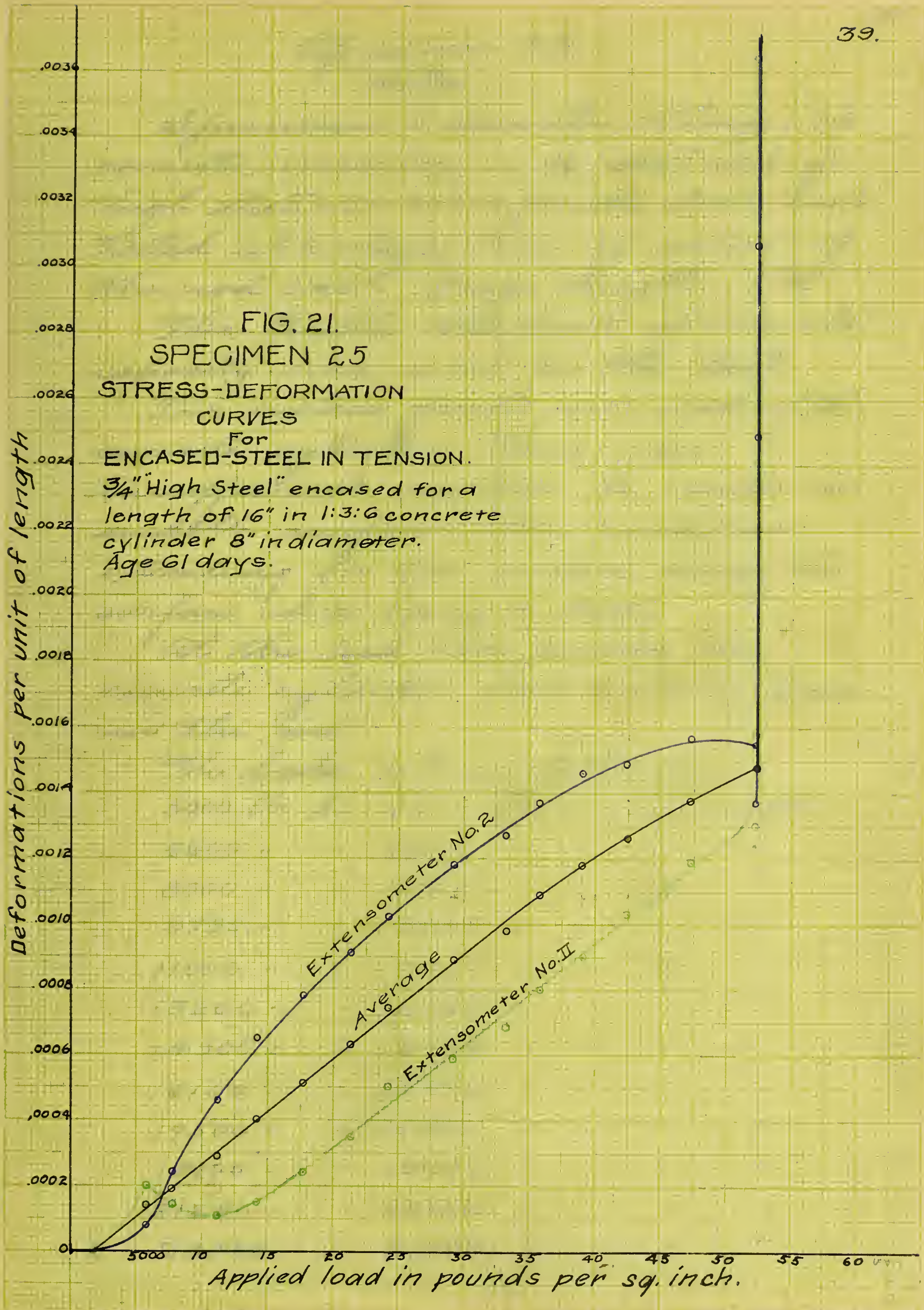


FIG. 21.

SPECIMEN 25

STRESS-DEFORMATION CURVES For ENCASED-STEEL IN TENSION.

3/4" "High Steel" encased for a length of 16" in 1:3:6 concrete cylinder 8" in diameter. Age 61 days.

Specimen 25.

Notes:-

Specimen 8" diameter, 16" long, 1:3:6 concrete, encasing a ¾" steel rod of "high steel" – i.e. 60000 pounds elastic limit. Tested at 61 days. Area of section of the rod 0.45□". Gage length 17⅞".

The Riehle machine of 100000 lb. capacity was used for the test.

Two inches from one end of the concrete cylinder, there was insufficient mortar to make a smooth surface, this condition extending for two inches along the surface and being ½" deep.

At the load 11000 pounds the concrete cylinder was entirely loose on the rod.

The loads set as follows:-

5000	lb.	to	4700	lb.	in	½	minute
6600	"	"	6250	"	"	1	"
8000	"	"	7700	"	"	½	"
9750	"	"	9250	"	"	1	"
11000	"	"	10650	"	"	½	"
13200	"	"	12850	"	"	"	"
14900	"	"	14100	"	"	"	"
16100	"	"	15500	"	"	"	"
17500	"	"	16800	"	"	"	"
19100	"	"	18600	"	"	"	"
21250	"	"	20700	"	"	"	"
23450	"	"	21400	"	"	"	"

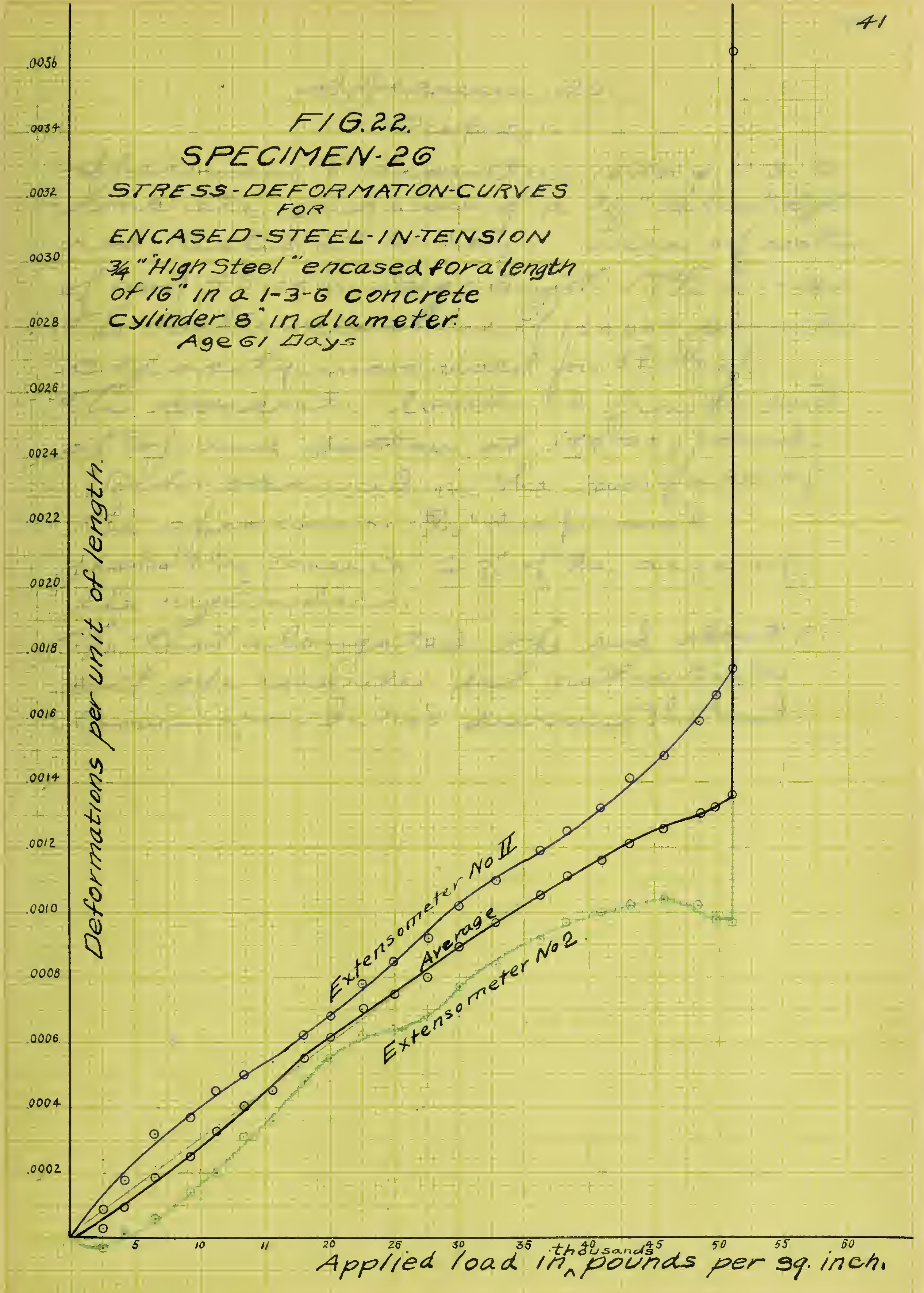


FIG.22.

SPECIMEN-26

STRESS-DEFORMATION-CURVES FOR ENCASED-STEEL-IN-TENSION

3/4" "High Steel" encased for a length of 16" in a 1-3-6 concrete cylinder 8" in diameter.

Age 61 Days

Specimen 26.

Notes:-

Specimen 8" diameter, 16" long, 1:3:6 concrete encasing a 3/4" steel (high") rod, tested at 61 days. Area of section of rod .45 sq.in. Gage-length 17 15/16 inches. The Riehle machine, of 100000 pounds capacity, was used for the test. The concrete loosened from the rod at top and bottom at 19,400 pounds. Voids occurred on the surface of the specimen 5/16" deep and probably covered 2% of the area of the cylinder. The test elongated the rod about 5" but the concrete did not entirely loosen from the rod during the test.

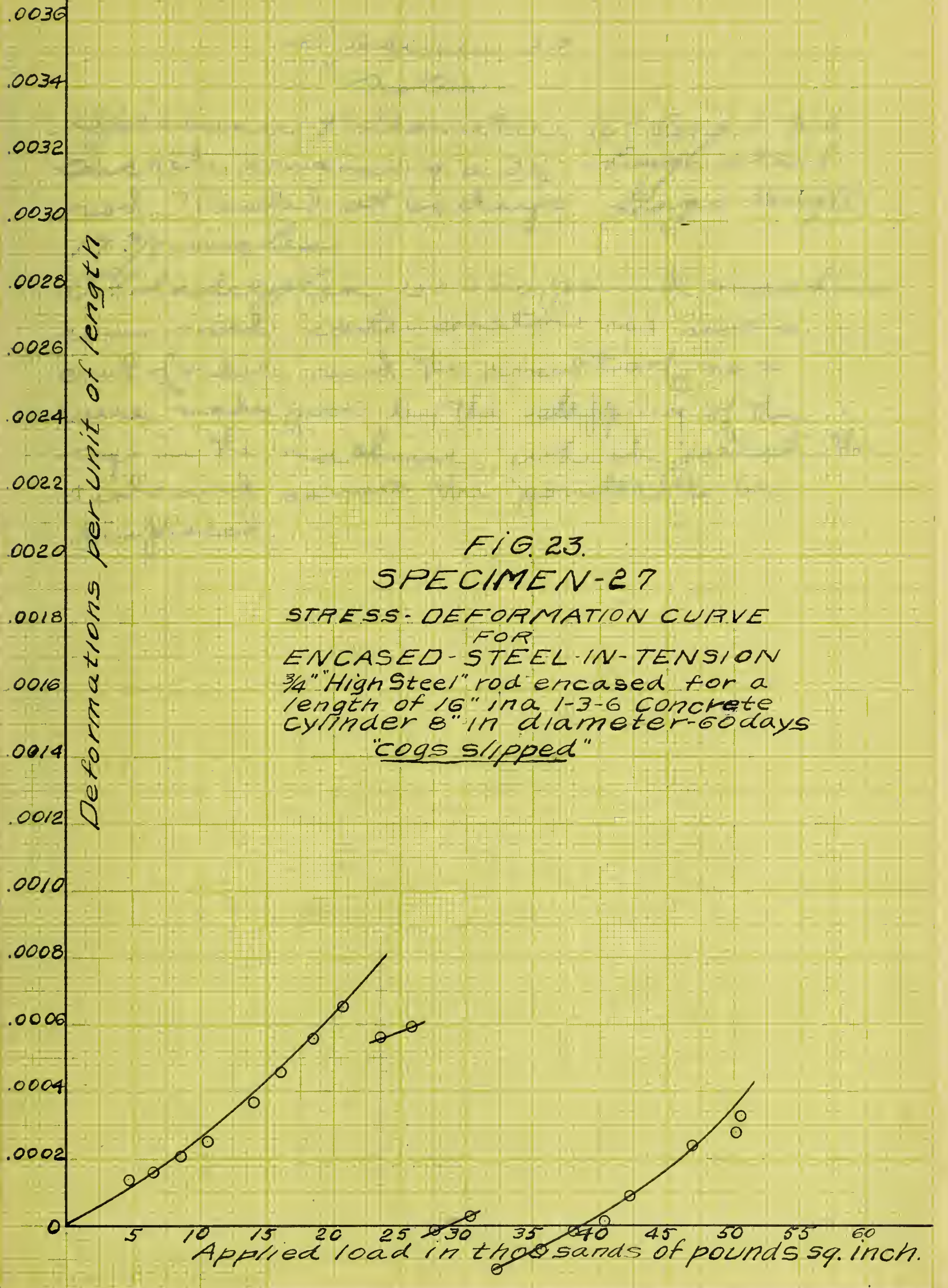


FIG. 23.
SPECIMEN-27
STRESS-DEFORMATION CURVE
FOR
ENCASED-STEEL-IN-TENSION
¾" "High Steel" rod encased for a length of 16" in a 1-3-6 Concrete cylinder 8" in diameter-60 days
"cogs slipped"

Specimen 27

Notes:-

Specimen 8" diameter, 16" long. 1:3:6 concrete encasing a 3/4" high steel rod. Tested at 60 days. Gage length 17 3/8 inches.

Philadelphia 100 000 pound machine was used, extensometer no. 1 was out of order, and the results of no. 2 were made poor by the slipping of the cogs in the machine, which "jarred" the dials and caused the pointer to be displaced.

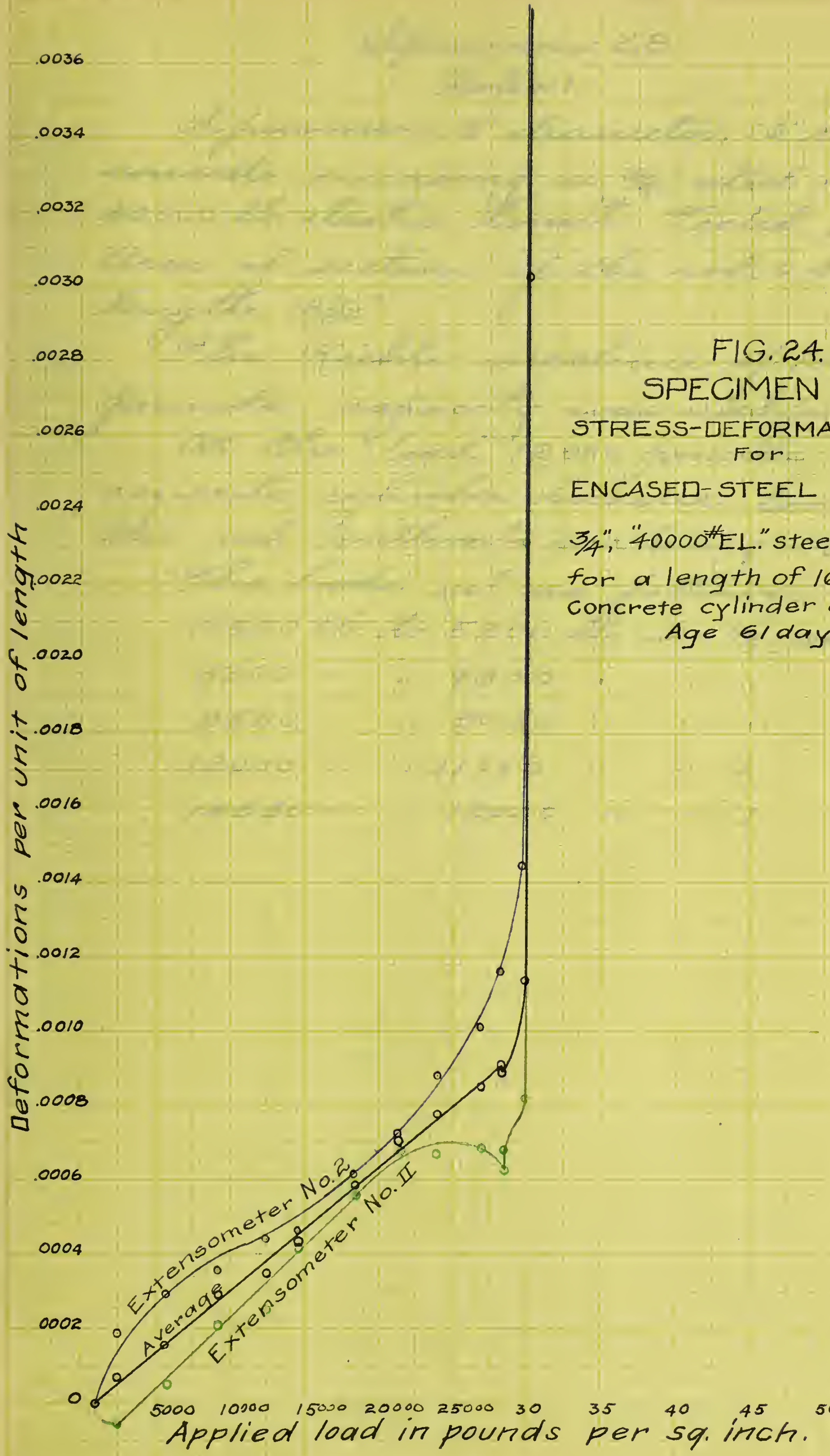


FIG. 24.

SPECIMEN 28

STRESS-DEFORMATION CURVES
For
ENCASED-STEEL IN TENSION.

3/4", "40000# EL." steel rod encased for a length of 16" in a 1:3:6 Concrete cylinder 8" diameter.
Age 61 days.

Specimen 28.

Notes:-

Specimen 8" diameter, 16" long, 1:3:6 concrete encasing a 3/4" steel rod of 40000 lb. elastic limit. Tested at 61 days. Area of section of the rod 0.45□" Gage length 18 1/2".

The Riehle machine of 100000 pounds capacity was used for the test.

At the load 12000 pounds, the concrete cylinder became loose on the rod without cracking visibly.

The loads set as follows:-

5500 lb. to 5200 lb. in 1/2 minute.
8200 " " 7800 " " " "
9550 " " 9050 " " " "
12000 " " 11000 " " 1 "
14530 " " 12000 " " 1 "

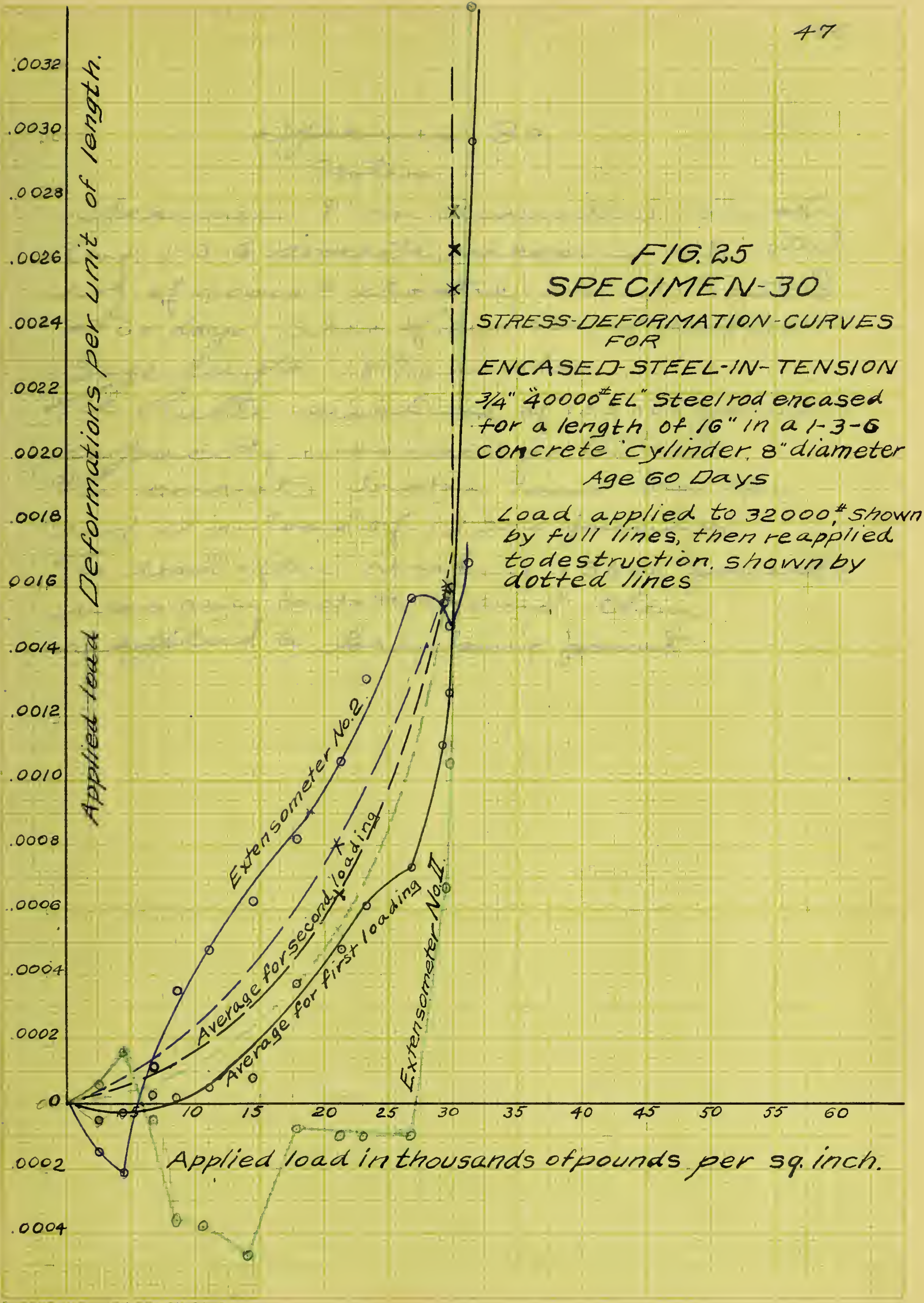


FIG. 25

SPECIMEN-30

STRESS-DEFORMATION-CURVES FOR ENCASED-STEEL-IN-TENSION

3/4" "40000# EL" Steel rod encased for a length of 16" in a 1-3-6 concrete cylinder, 8" diameter

Age 60 Days

Load applied to 32000# shown by full lines, then reapplied to destruction, shown by dotted lines

Specimen 30.

Notes:-

Specimen 8" in diameter, 16 inches long, 1:3:6 concrete encasing a 3/4" steel rod of 40000# elastic limit. Tested at 60 days. Area of section of rod .45□"
Gage length 18 7/16 inches.
The Riehle machine of 100 000 pounds capacity was used for the test.
The concrete broke loose from the rod at a load of 13 200 pounds.
The load after reaching 13600 pounds was run back to 0 and then reapplied to breaking point.

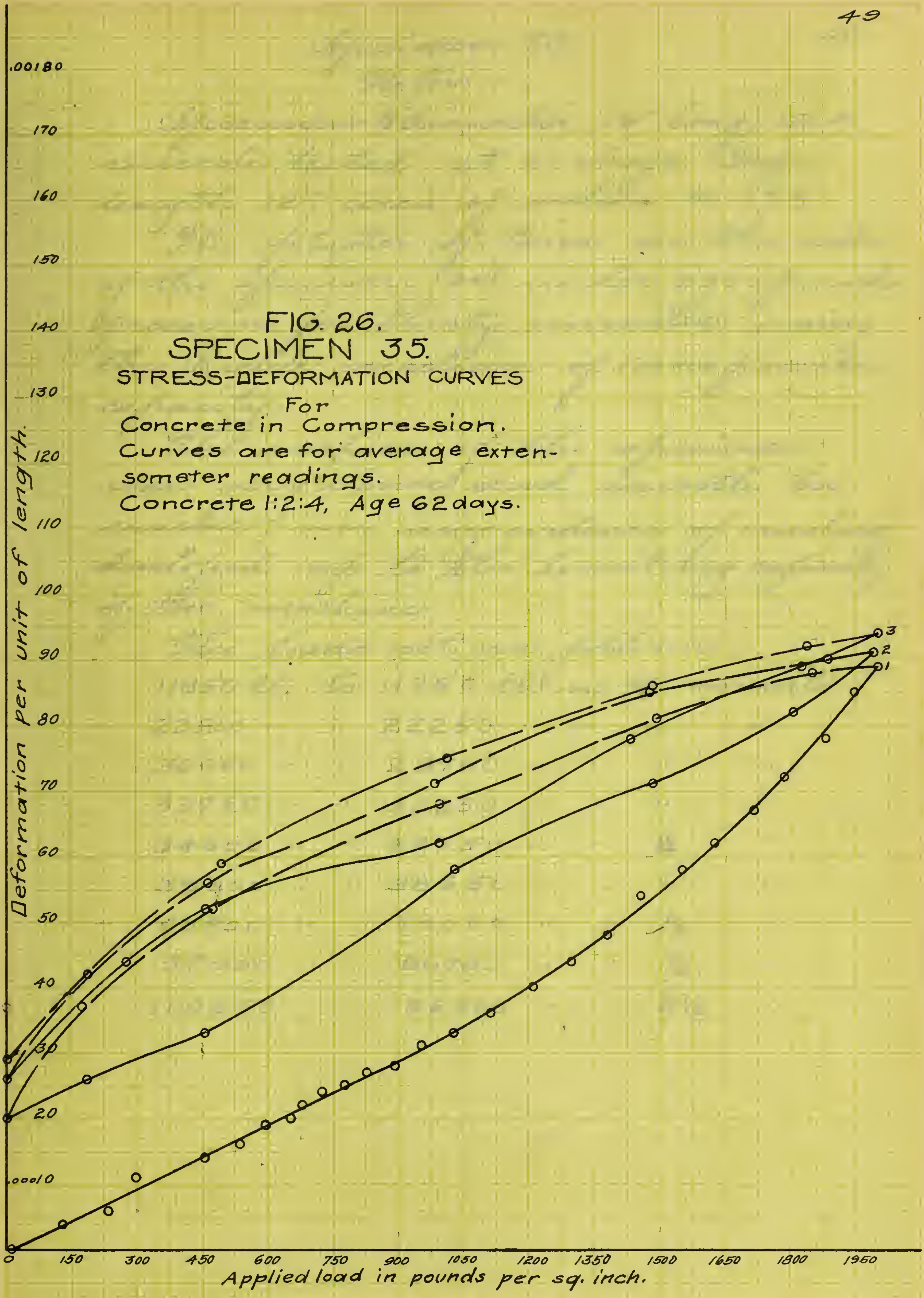


FIG. 26.
SPECIMEN 35.
STRESS-DEFORMATION CURVES
For
Concrete in Compression.
Curves are for average extensometer readings.
Concrete 1:2:4, Age 62 days.

Specimen 35.

Notes:-

Specimen 8" diameter, 16" long, 1:2:4 concrete, tested at 61 days. Gage length 12". Area of section 50.25 □"

The plaster of Paris on the ends of the specimen set under 2500 pounds pressure for thirty minutes, using the Riehle machine of 100 000 pounds capacity.

The surface of the specimen was very dense and smooth. No cracks, nor any evidence of crushing developed up to the limiting capacity of the machine.

The loads set as follows:-

11850 lb. to 11350 lb. in 1/2 minute.
22800 " " 22250 " " " "
30000 " " 29700 " " " "
32750 " " 32250 " " " "
34000 " " 33750 " " 1/4 "
39000 " " 38650 " " " "
60800 " " 60000 " " 1/2 "
97950 " " 96700 " " 1/2 "
100550 " " 96900 " " 2 1/2 "

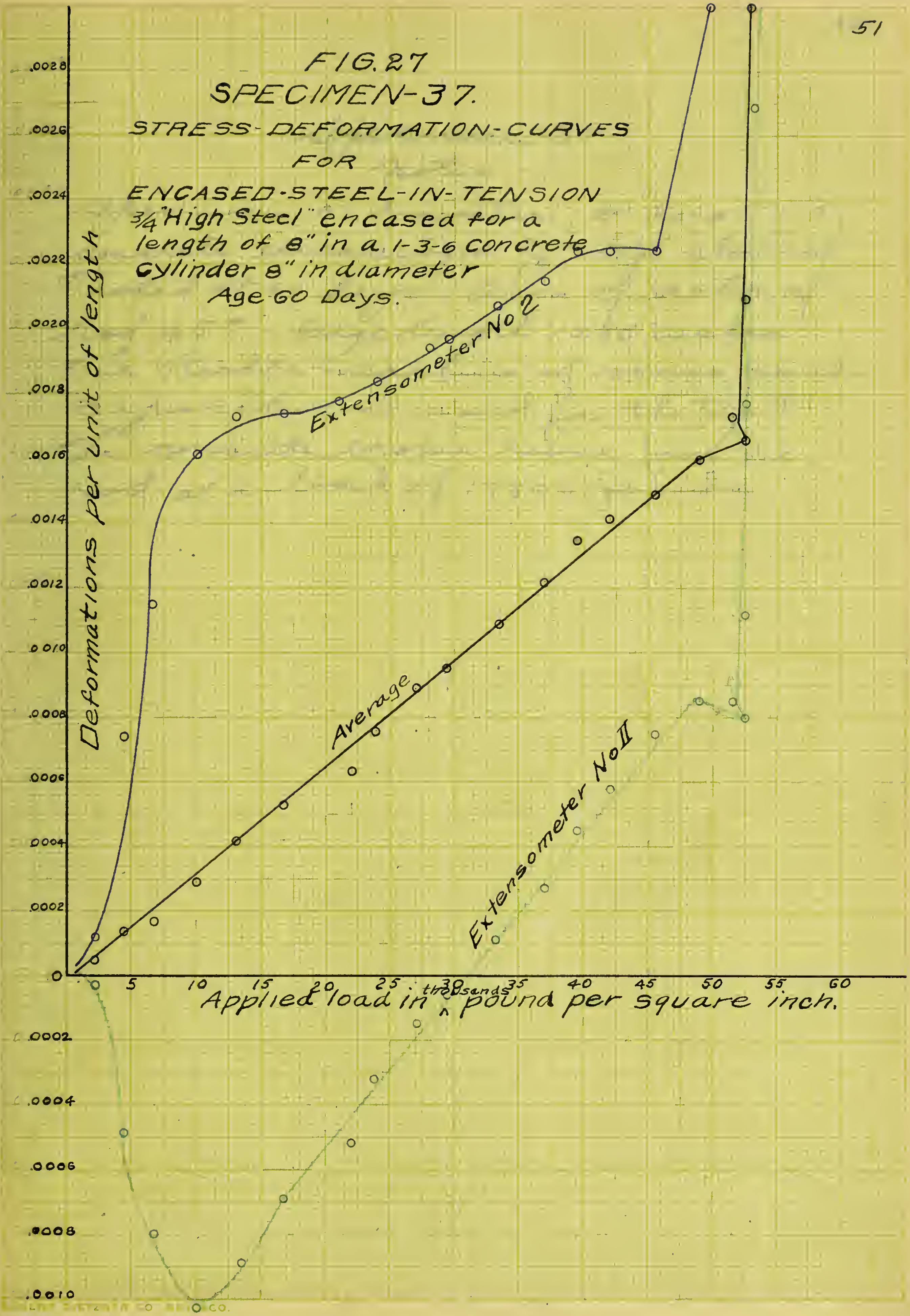


FIG. 27

SPECIMEN-37.

STRESS-DEFORMATION-CURVES
FOR
ENCASED-STEEL-IN-TENSION

3/4" "High Steel" encased for a
length of 8" in a 1-3-6 concrete
cylinder 8" in diameter
Age 60 Days.

Specimen 37

Notes:-

Specimen 8" diameter, 8" long, 1:3:6 concrete encasing a 3/4" hig. steel rod. Tested at 60 days. Area of section of rod .45□" Gage length 10.85 inches. The Riehle machine of 100000 pounds capacity was used for the test. The concrete broke loose from the rod at a load of 17800 pounds.

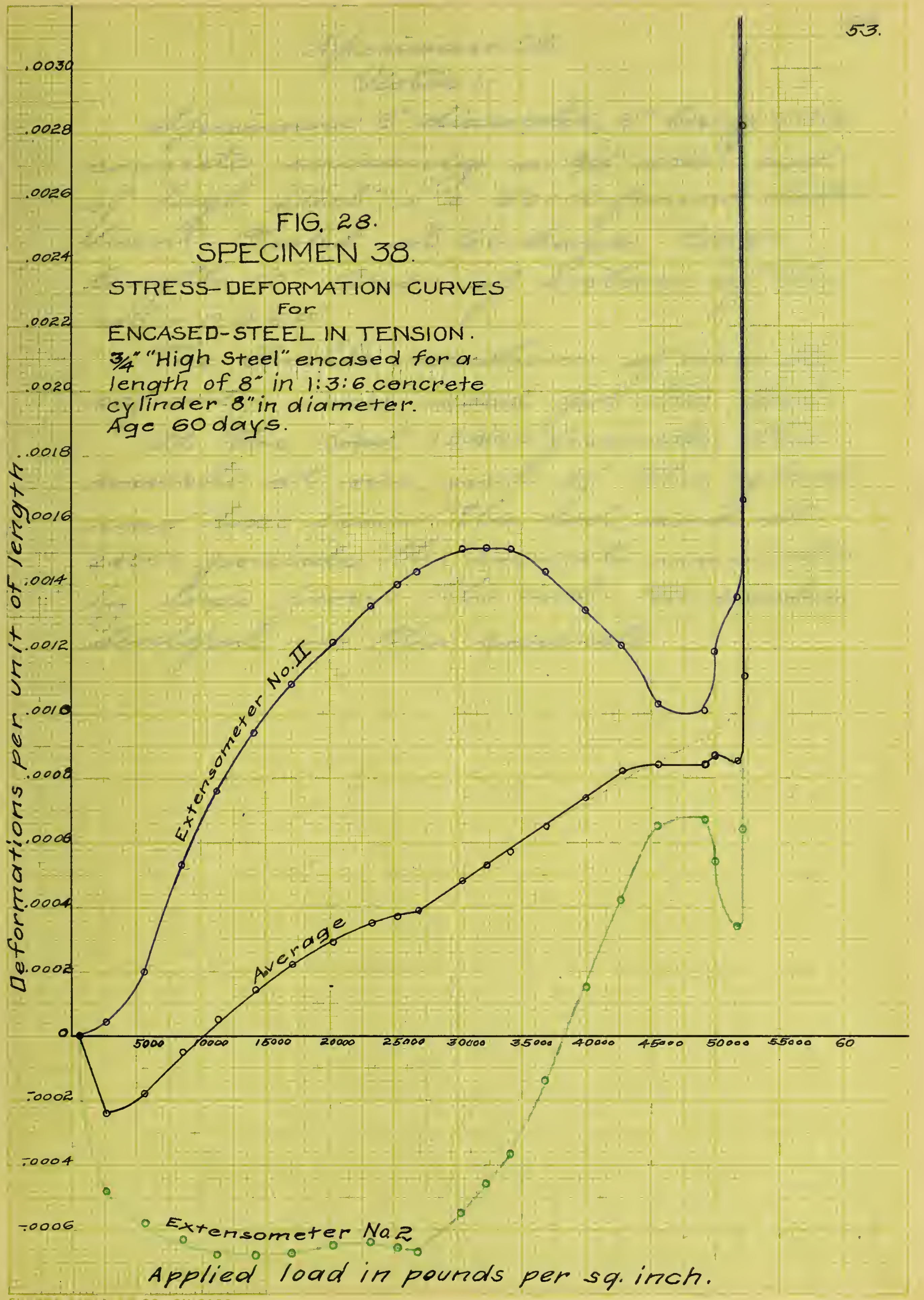


FIG. 28.

SPECIMEN 38.

STRESS-DEFORMATION CURVES
For
ENCASED-STEEL IN TENSION.

3/4" "High Steel" encased for a length of 8" in 1:3:6 concrete cylinder 8" in diameter.
Age 60 days.

Specimen 38.

Notes:-

Specimen 8" diameter, 8" long, 1:3:6 concrete, encasing a 3/4" steel rod of "high steel"; i.e. 60000 pound elastic limit. Tested at 60 days. Gage length 10". Area of section of the rod = 0.45□"

The Riehle machine of 10000 lb. capacity was used for the test.

At the load 15400 pounds, the concrete at one end of the cylinder was loose from the rod, and at 24000 pounds the concrete was entirely loose from the rod. No cracks developed in the concrete.

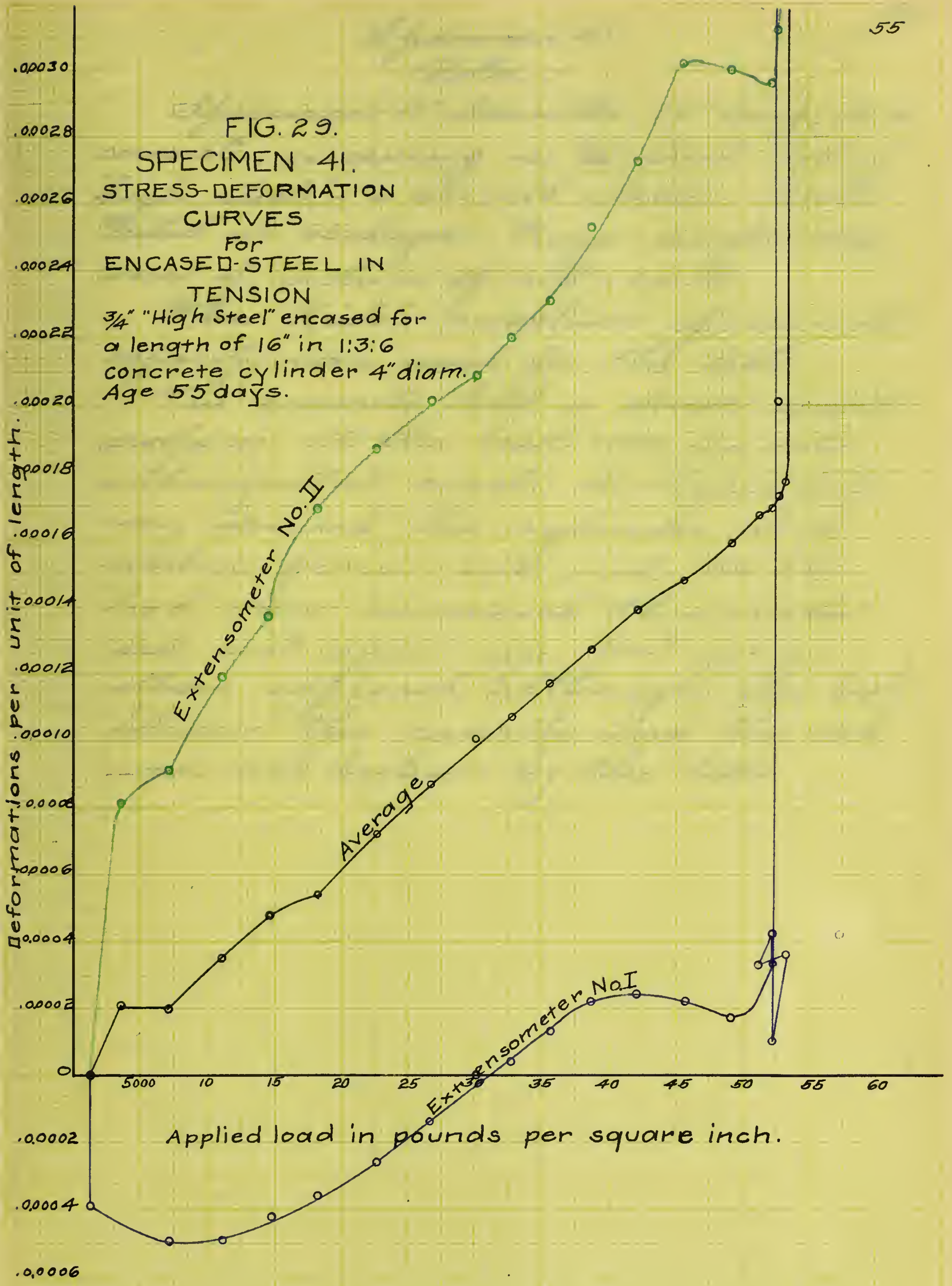


FIG. 29.

SPECIMEN 41.

STRESS-DEFORMATION CURVES For ENCASED-STEEL IN TENSION

3/4" "High Steel" encased for a length of 16" in 1:3:6 concrete cylinder 4" diam. Age 55 days.

Specimen 41.

Notes:-

Specimen 4" diameter, 16" long, 1:3:6 concrete, encasing a 3/4" steel rod of "high steel," i.e 60000 lb. elastic limit. Tested at 55 days. Gage length 18 1/24". Area of section of rod = 0.45□"

The Riehle machine of 100000 lb. capacity was used for the test.

The concrete had a dense, smooth surface. At the load 11000 pounds, a horizontal crack developed half way around the cylinder at 6 inches from one end. As the load was increased this crack did not open up, but none others appeared although the bond between the concrete and the rod was not broken by the test.

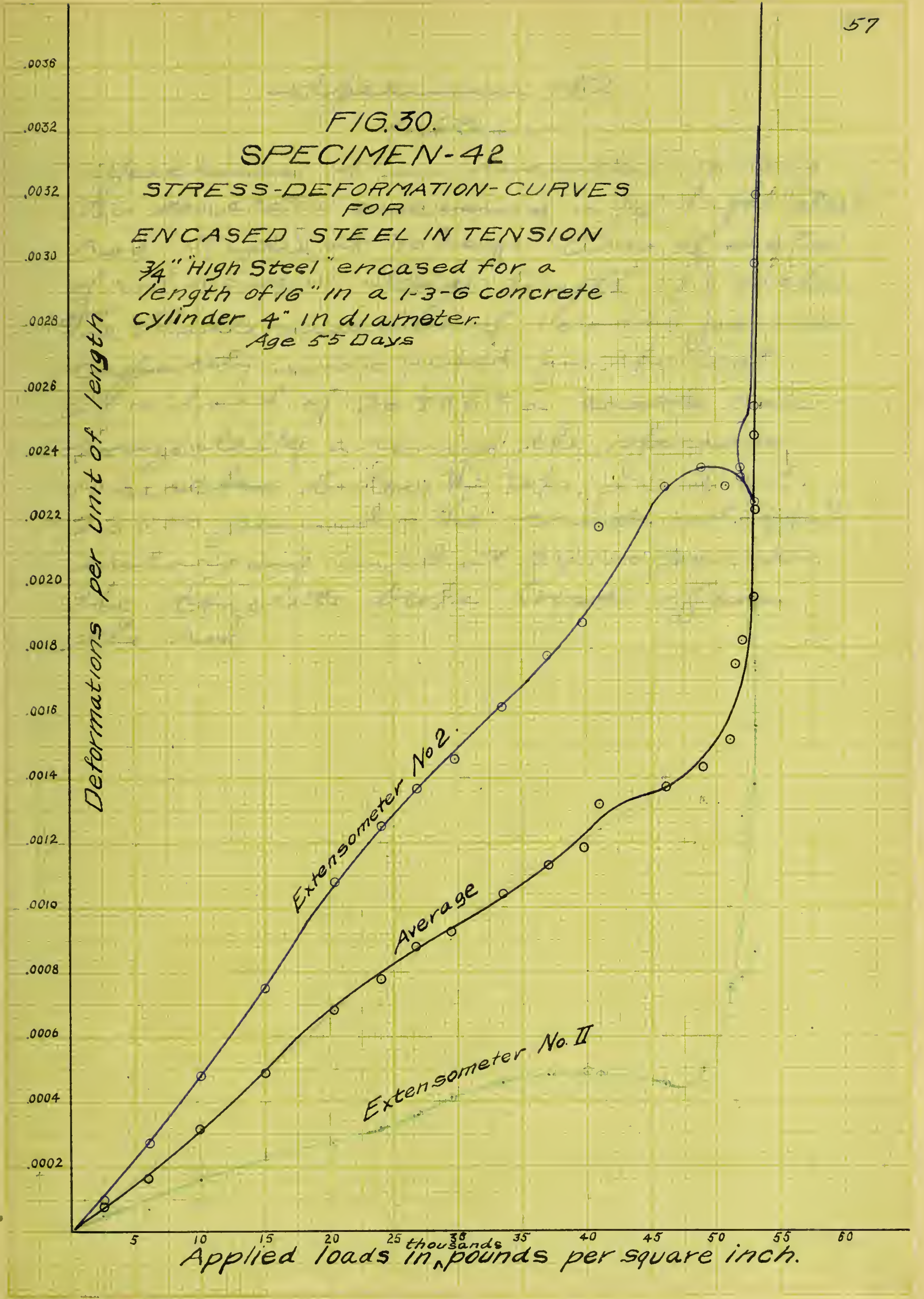


FIG. 30.
SPECIMEN-42
STRESS-DEFORMATION-CURVES
FOR
ENCASED STEEL IN TENSION
¾" "High Steel" encased for a length of 16" in a 1-3-6 concrete cylinder 4" in diameter.
Age 55 Days

Specimen 42.

Notes:-

Specimen 4" in diameter, 16" long 1:3:6 concrete encasing a 3/4" high steel rod. Tested at 60 days. Area of section of rod .45 sq. in. Gage length 18.5 inches. The Riehle machine of 100000 pounds capacity was used for the test. At a load of 20800# a crack ran horizontally around the specimen 10 inches below the top, and at 23500 pounds the crack stopped enlarging and at 24100 pounds the concrete broke loose from the rod.

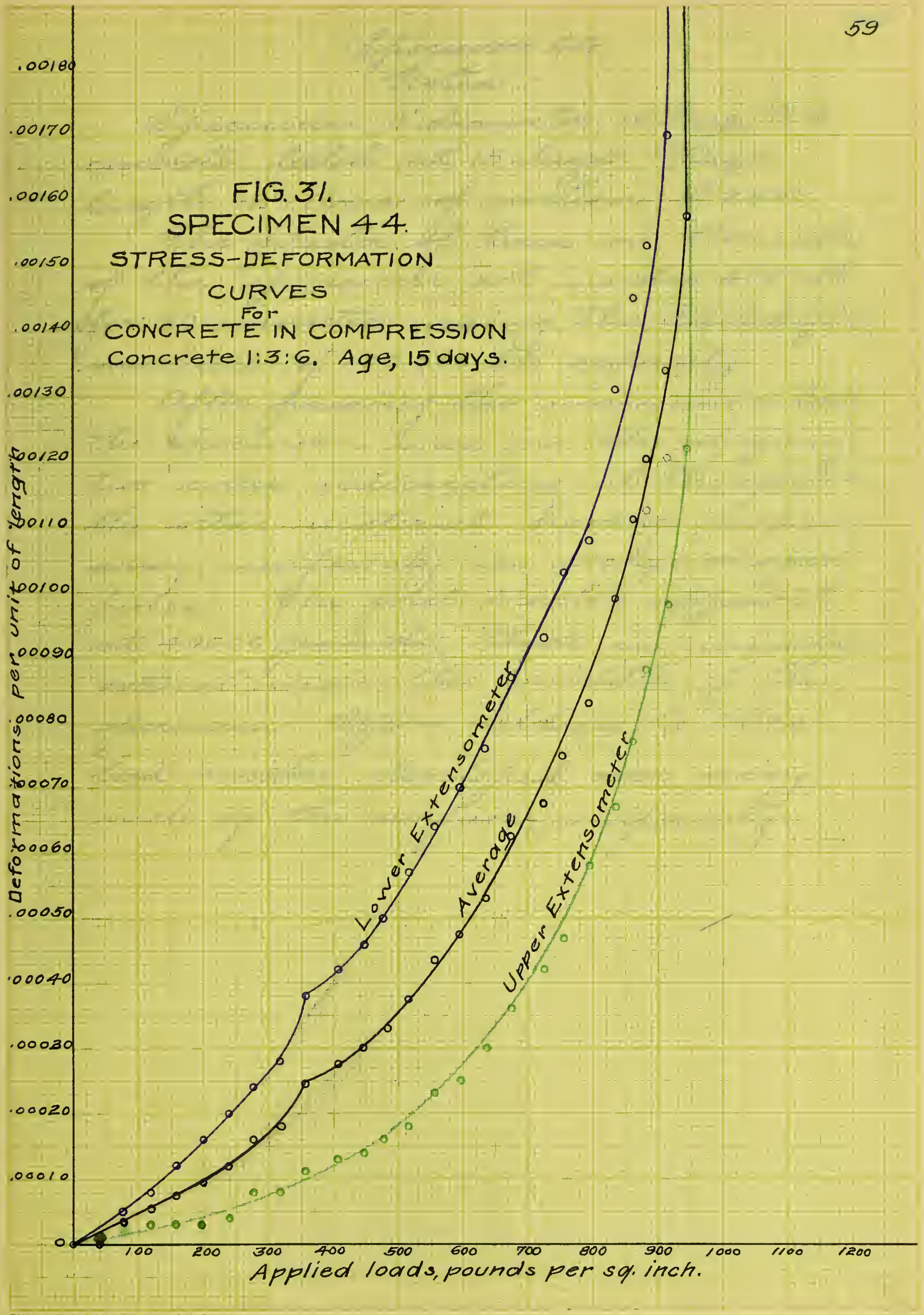


FIG. 31.

SPECIMEN 44.

STRESS-DEFORMATION CURVES For CONCRETE IN COMPRESSION

Concrete 1:3:6. Age, 15 days.

Specimen 44.

Notes:-

Specimen 8" diameter, 16" long, 1:3:6 concrete, tested at 15 days. Gage length 12". Area of section 50.25□".

The plaster of Paris on the ends of the specimen set under 4000 lb. for 20 minutes, using the Philadelphia machine of 100 000 lb. capacity.

After passing the maximum load the specimen was in the shape of two cones intersecting at the apexes, the other material having broken away uniformly in wedge-shaped pieces. The first cracks appeared at 40000 pounds, three in number, vertical, near the middle of the specimen. Upon adding to this load cracks developed over every inch of the surface, uniformly.

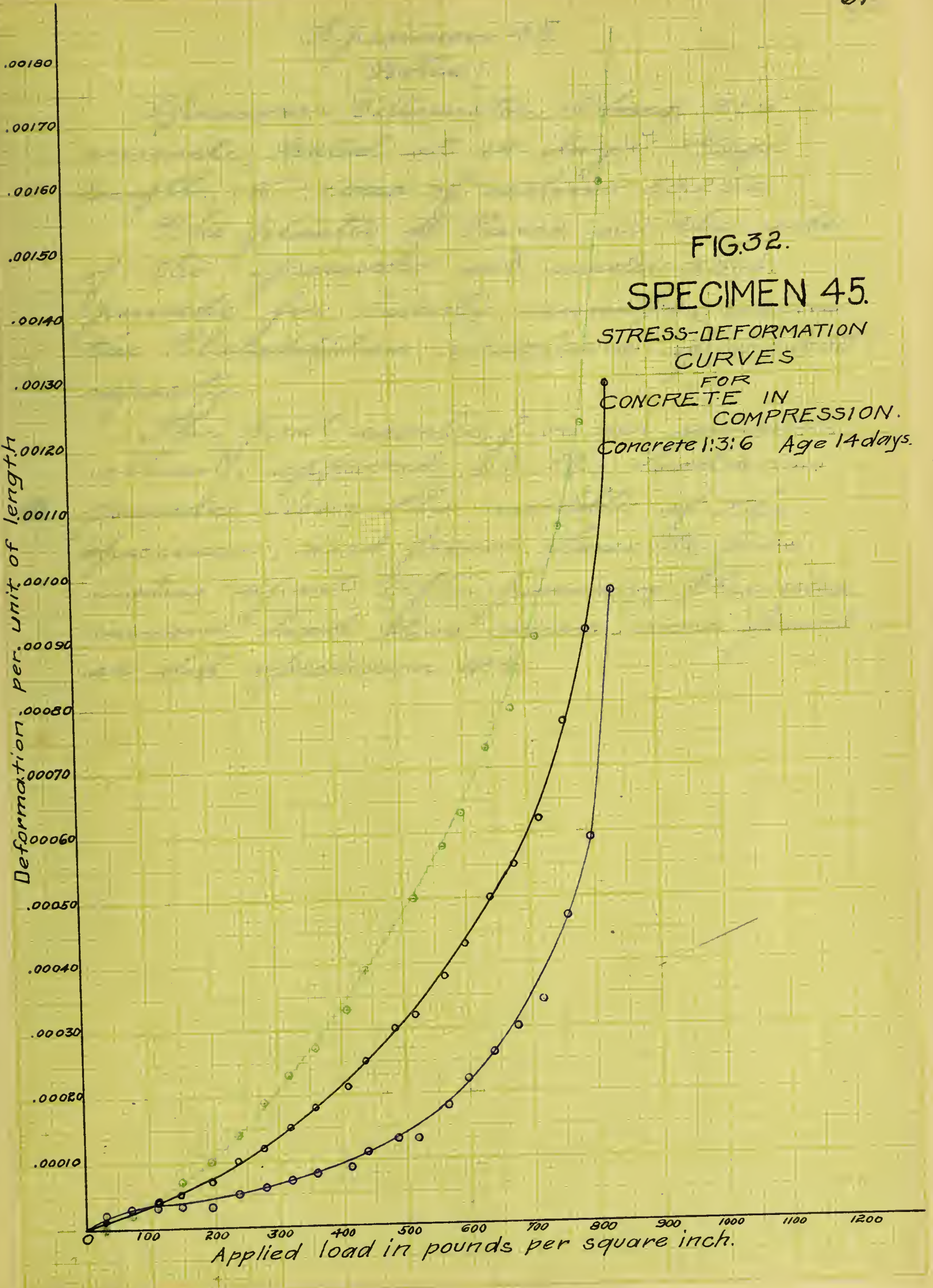


FIG.32.

SPECIMEN 45.

STRESS-DEFORMATION CURVES FOR CONCRETE IN COMPRESSION.

Concrete 1:3:6 Age 14 days.

Specimen 45.

Notes:-

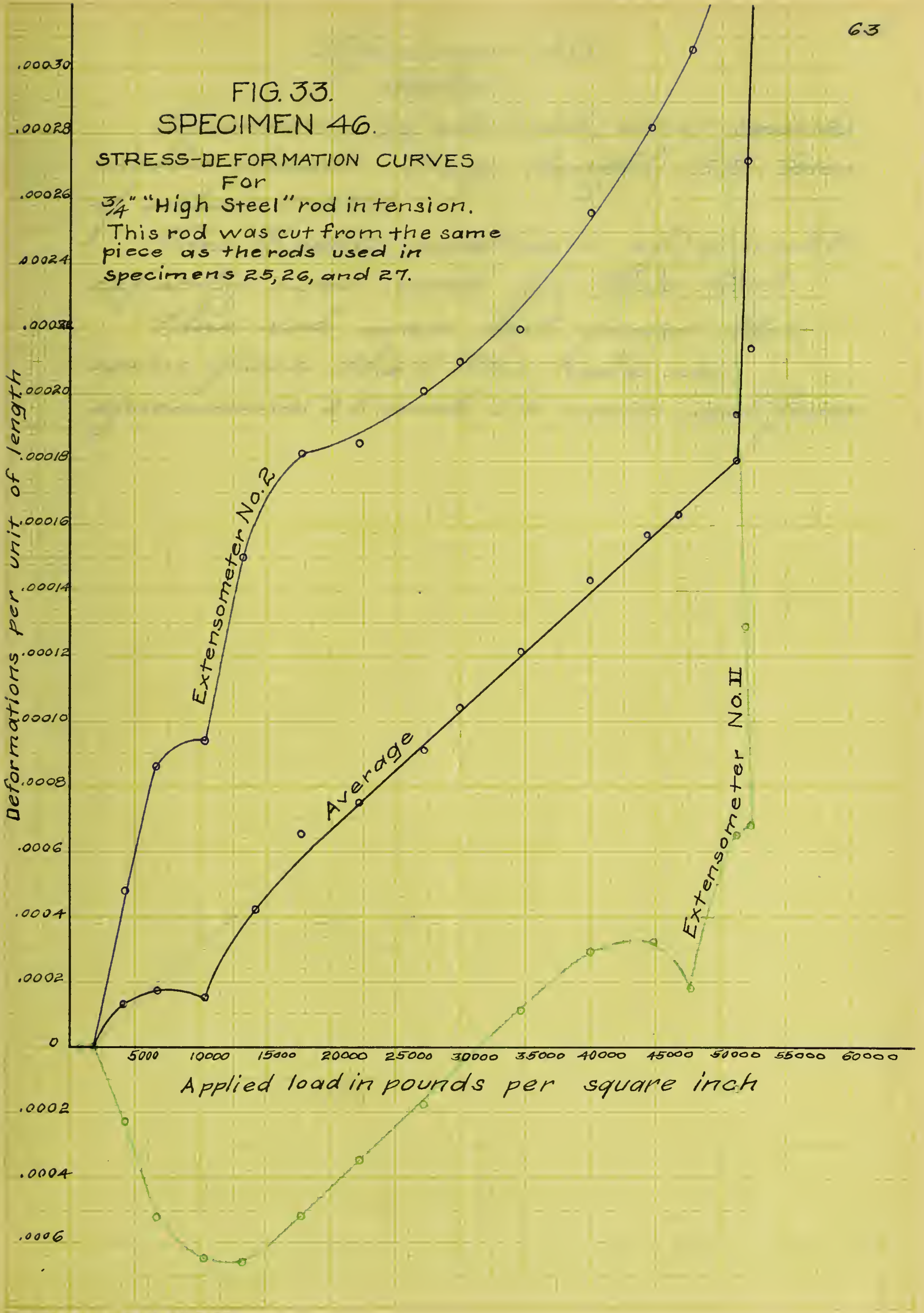
Specimen 8" diameter, 16" long, 1:3:6 concrete, tested at 14 days. Gage length, 12". Area of section 50.25□"

The plaster of Paris on the ends of the specimen set under 3500 pounds for twenty minutes, using the Philadelphia machine of 100 000 lb. capacity.

The first cracks, five in number, vertical, appeared at the load 42000 pounds, near the middle of the specimen, and from three to five inches apart. After passing the maximum load two cones were formed as did specimen 44.

FIG. 33.
SPECIMEN 46.

STRESS-DEFORMATION CURVES
For
¾" "High Steel" rod in tension.
This rod was cut from the same piece as the rods used in specimens 25, 26, and 27.



Specimen 46.

Notes:-

Specimen, 3/4" steel rod, 60000 pounds elastic limit. Gage length 15½". Area of section 0.450□".

The Riehle machine of 100 000 lb. capacity was used for this test.

This rod was cut from the same piece that the rods in specimens 25 and 26 were cut from.

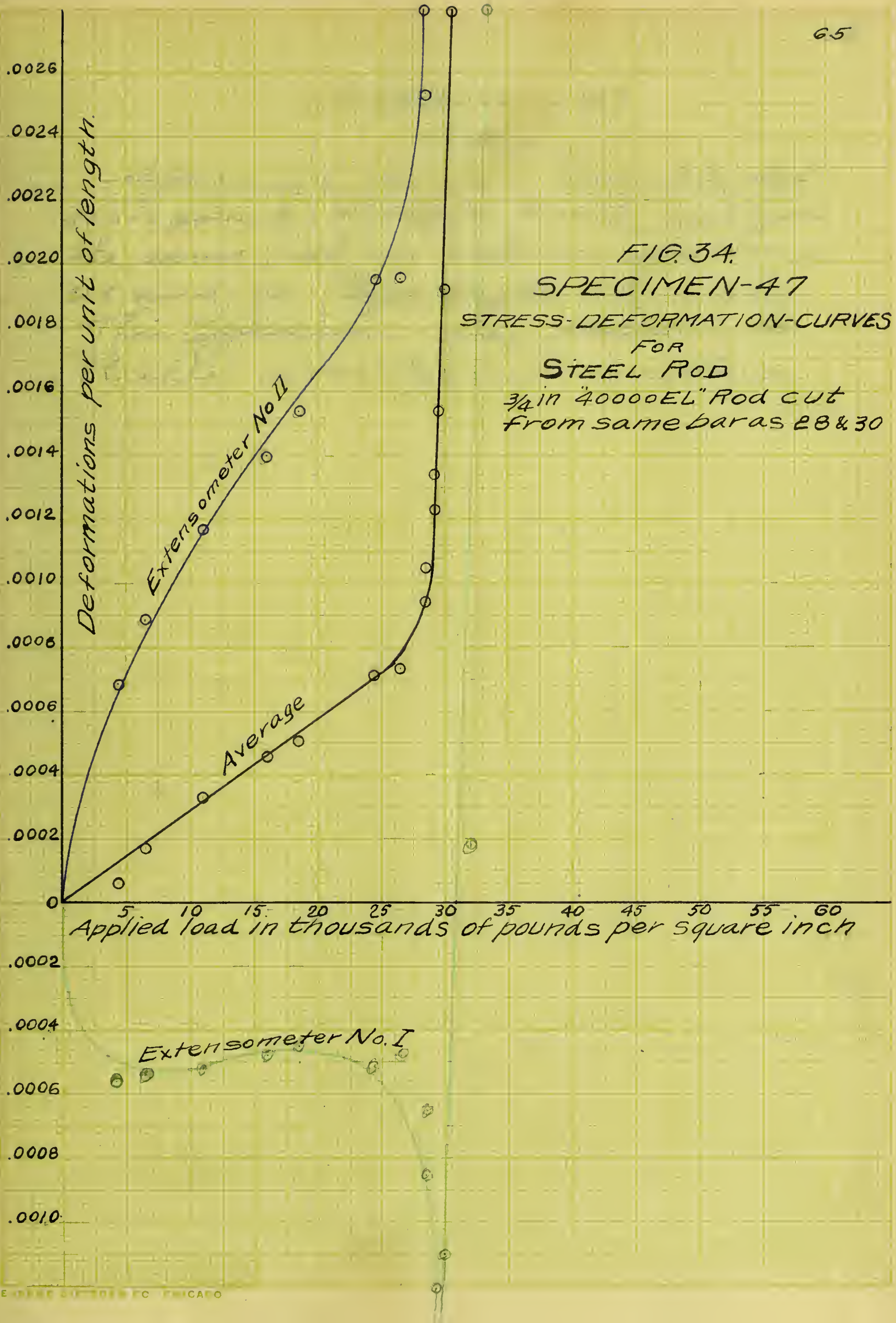


FIG. 34.

SPECIMEN-47

STRESS-DEFORMATION-CURVES

FOR

STEEL ROD

3/4 in "40000 EL" Rod cut
from same bar as 28 & 30

Specimen 47.

Notes:-

Specimen 47 is a round 3/4" rod 40000 pound elastic limit, cut from the same rod as rods in specimens 28 and 30. Gage length $11\frac{15}{16}$ inches. This specimen was tested in the Riehle 100000 pound machine,

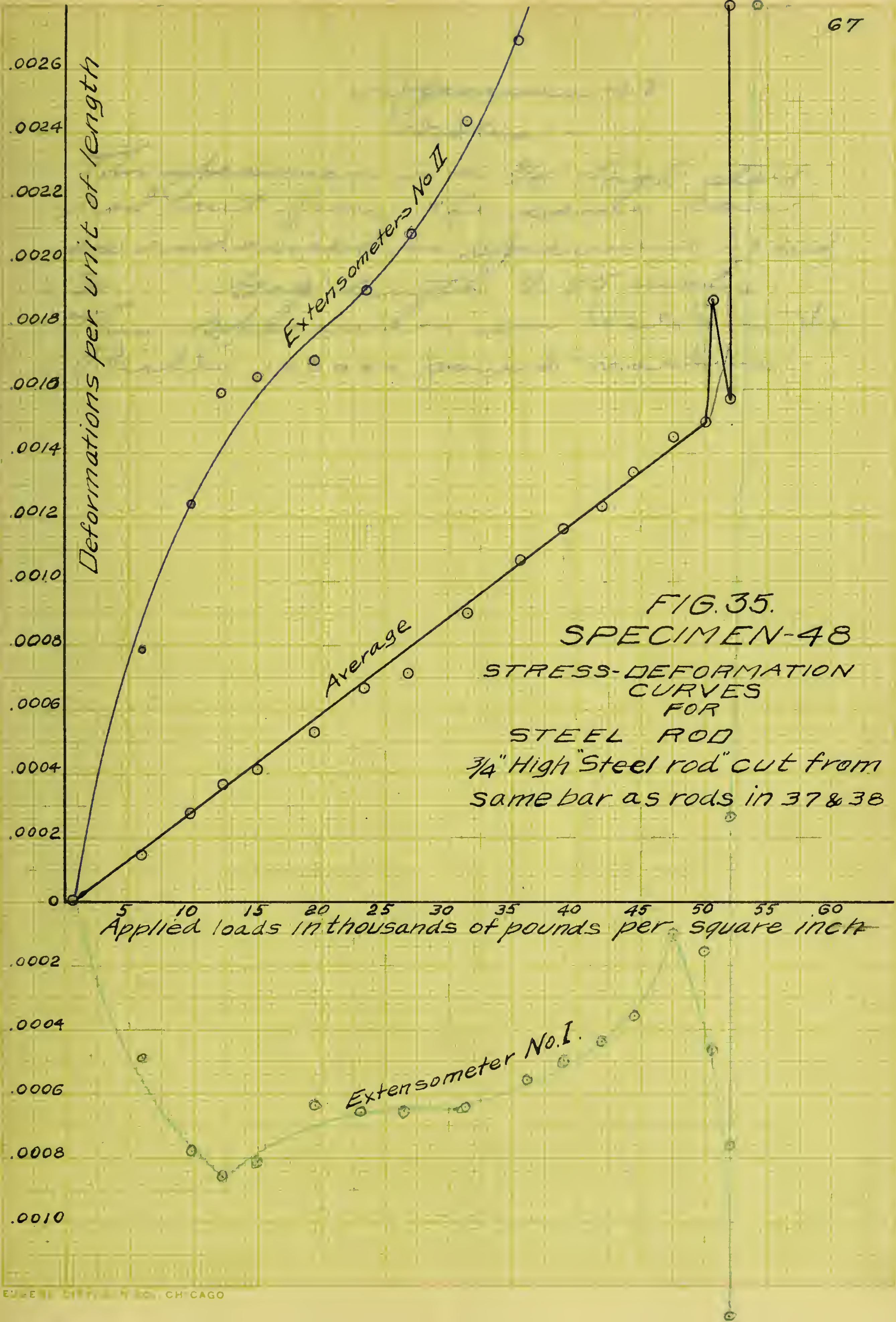


FIG. 35.
SPECIMEN-48
STRESS-DEFORMATION
CURVES
FOR
STEEL ROD
¾" High "Steel rod" cut from
same bar as rods in 37 & 38

Specimen 48

Notes:-

This specimen is a 3/4" high steel rod cut from the same bar as rods used in specimens 28 and 30. Gage length 9.95 inches. The specimen was tested in the Riehle 100000 pound machine.

Tests of Cubes.

3 cubes of 1:2:4 concrete were tested - one perpendicular to the layers of tamping gave 69,300#, and 2 tested parallel to layers of tamping gave 70,250# and 52,750# as maximum strength. It seems probable that eccentric loading accounts for the above low value of 52750#. Age 60 days.

2 cubes were tested - of 1:3:6 concrete; one tested perpendicular to layers of tamping gave 32650# and one parallel to layers of tamping gave 37300#.

From the above results it seems as if the cubes gave the greatest strength when tested parallel to layers of tamping.

SPECIMEN 1.

Applied Loads in Pounds		Extensometer Readings		Deformations Inches		Deformations Per Inch	
Total	Per Sq. In.	Upper	Lower	Upper	Lower	Upper	Lower
0000	00	.1348	.1516	.0000	.0000	.00000	.00000
3000	60	.1347	.1511	.0001	.0005	.00001	.00004
5500	109	.1346	.1506	.0002	.0010	.00002	.00008
7750	148	.1342	.1500	.0006	.0016	.00005	.00013
9600	191	.1340	.1495	.0008	.0021	.00007	.00018
12300	244	.1335	.1484	.0013	.0032	.00011	.00027
14500	288	.1332	.1477	.0016	.0039	.00013	.00033
16200	322	.1328	.1469	.0020	.0047	.00017	.00039
17800	354	.1320	.1461	.0028	.0055	.00023	.00046
19800	394	.1315	.1450	.0033	.0066	.00028	.00055
21900	416	.1309	.1446	.0039	.0070	.00033	.00058
23800	474	.1305	.1420	.0043	.0096	.00038	.00080
25600	511	.1301	.1407	.0047	.0109	.00039	.00091
27100	533	.1297	.1390	.0051	.0126	.00043	.00105
28700	571	.1293	.1377	.0055	.0139	.00046	.00116
30400	605	.1289	.1359	.0059	.0157	.00049	.00131
32000	637	.1280	.1340	.0068	.0176	.00057	.00147
33100	659	.1270	.1315	.0078	.0201	.00065	.00168
34800	692	.1265	.1296	.0083	.0220	.00069	.00183
35800	713	.1255	.1260	.0093	.0256	.00078	.00213
36400	725	.1261	.1240	.0087	.0276	.00073	.00230
38100	758	.1265	.1228	.0083	.0288	.00069	.00240
39200	780	.1268	.1173	.0080	.0343	.00067	.00286
40100	798	.1277	.1108	.0071	.0408	.00059	.00340
41200	820	.1358	.1079	-.0010	.0437	-.00008	.00364

SPECIMEN 11.

Applied Loads Pounds		Extensometer Readings		Deformation Inches		Deformations Per Inch.	
Total	Per Sq. In.	Upper	Lower	Upper	Lower	Upper	Lower
2310	46	.4364	.4581	.0000	.0000	.00000	.00000
3350	67	.4364	.4581	.0000	.0000	.00000	.00000
5300	106	.4362	.4576	.0002	.0005	.00002	.00004
8000	159	.4359	.4571	.0005	.0010	.00004	.00008
10600	211	.4357	.4564	.0007	.0017	.00005	.00014
12300	245	.4351	.4558	.0013	.0023	.00010	.00018
14100	281	.4350	.4551	.0014	.0030	.00010	.00023
16400	327	.4341	.4541	.0023	.0040	.00018	.00031
17600	351	.4335	.4531	.0029	.0050	.00022	.00039
18900	376	.4331	.4524	.0033	.0057	.00026	.00044
20500	408	.4312	.4513	.0042	.0068	.00033	.00053
21500	428	.4240	.4496	.0124	.0085	.00096	.00066
21100	420	.4201	.4494	.0163	.0087	.00126	.00067
20200	402	.4157	.4490	.0207	.0091	.00160	.00071
19000	371	.4118	.4488	.0246	.0093	.00191	.00072
19000	371	.4096	.4470	.0268	.0111	.00208	.00086

SPECIMEN-13.

Applied Loads in Pounds		Extensometer Readings		Deformations Inches		Deformations Per. Inch	
Total	Per. Sq. In.	Upper	Lower	Upper	Lower	Upper	Lower.
00	00	.1796	.0583	.0000	.0000	.00000	.00000
2300	46	.1793	.0580	.0003	.0003	.00003	.00003
5300	105	.1789	.0578	.0007	.0005	.00006	.00004
8000	159	.1784	.0573	.0012	.0010	.00010	.00008
10100	220	.1780	.0569	.0016	.0014	.00013	.00012
13000	257	.1774	.0563	.0022	.0020	.00018	.00017
15500	306	.1769	.0559	.0027	.0024	.00024	.00020
18200	360	.1759	.0551	.0037	.0032	.00031	.00025
20600	407	.1752	.0545	.0044	.0038	.00037	.00032
22800	451	.1745	.0540	.0051	.0043	.00043	.00036
25400	501	.1730	.0530	.0066	.0055	.00055	.00044
27700	548	.1719	.0526	.0077	.0057	.00064	.00048
29800	590	.1700	.0510	.0096	.0073	.00080	.00061
33000	652	.1677	.0500	.0119	.0083	.00091	.00070
34000	672	.1655	.0492	.0141	.0091	.00118	.00076
36000	712	.1630	.0482	.0166	.0101	.00139	.00084
37900	750	.1529	.0450	.0267	.0133	.00224	.00111
38900	770	.1525	.0400	.0271	.0183	.00226	.00154
40000	795	Max.					

SPECIMEN 14.

Applied Loads in Pounds		Extensometer Readings.		Deformations in Inches		Deformations Per Inch	
Total	Per Sq. In.	Upper	Lower	Upper	Lower	Upper	Lower.
0000	00	.2748	.3137	.0000	.0000	.00000	.00000
2300	46	.2748	.3133	.0000	.0004	.00000	.00003
4100	82	.2747	.3119	.0001	.0018	.00001	.00015
6200	123	.1650	.3115	.0005	.0022	.00004	.00018
8100	161	.1648	.3110	.0007	.0027	.00006	.00023
10500	209	.1645	.3102	.0010	.0035	.00008	.00029
12400	227	.1641	.3096	.0014	.0041	.00011	.00034
15000	299	.1638	.3088	.0017	.0049	.00014	.00041
17500	348	.1629	.3075	.0026	.0062	.00022	.00052
19200	382	.1623	.3070	.0032	.0067	.00027	.00056
21000	418	.1615	.3059	.0040	.0078	.00033	.00065
22700	452	.1605	.3049	.0050	.0088	.00042	.00073
25000	498	.1591	.3030	.0064	.0107	.00053	.00089
26800	533	.1580	.3015	.0075	.0122	.00063	.00102
28800	573	.1560	.2990	.0095	.0147	.00080	.00123
30200	601	.1540	.2970	.0115	.0167	.00096	.00139
31800	635	.1517	.2945	.0138	.0192	.00115	.00160
33000	657	.1495	.2920	.0160	.0217	.00133	.00181
34700	691	.1465	.2885	.0190	.0252	.00158	.00210
36400	730	.1430	.2845	.0225	.0292	.00188	.00243
36900	734	.1405	.2800	.0250	.0337	.00208	.00281
37600	748	.1355	.2700	.0300	.0437	.00250	.00364
39800	792						

SPECIMEN-16

Applied Loads in Pounds		Extensometer Readings		Deformations Inches		Deformation Per Inch	
Total	Per Sq In	Upper	Lower	Upper	Lower	Upper	Lower
00	00	.2725	.2027	.0000	.0000	.00000	.00000
3000	59	.2723	.2025	.0002	.0002	.00002	.00002
3000	59	.2372	.2065	.0002	.0002	.00002	.00002
00	0	.2373	.2070	.0001	-.0003	.00001	-.00003
00	0	.2850	.2160	.0001	-.0003	.00001	-.00003
3100	61	.2848	.2155	.0003	.0002	.00003	.00002
6100	121	.2846	.2150	.0005	.0008	.00004	.00007
6100	121	.1913	.2243	.0005	.0008	.00004	.00007
2800	61	.1915	.2247	.0003	.0004	.00003	.00003
00	0	.1916	.2250	.0002	.0001	.00002	.00001
00	0	.2155	.2098	.0002	.0001	.00002	.00001
3600	71	.2155	.2093	.0002	.0006	.00002	.00005
6150	122	.2154	.2090	.0003	.0009	.00003	.00008
9350	186	.2150	.2085	.0007	.0014	.00006	.00014
9350	186	.2061	.2018	.0007	.0014	.00006	.00012
4000	71	.2059	.2018	.0005	.0014	.00004	.00012
00	0	.2020	.2018	-.0036	.0014	-.00030	.00012
00	0	.1914	.2185	-.0036	.0014	-.00030	.00012
5000	99	.1911	.2179	-.0033	.0020	-.00028	.00017
8700	173	.1909	.2173	-.0031	.0026	-.00026	.00022
12000	238	.1905	.2173	-.0027	.0026	-.00023	.00022
8400	167	.1856	.1870	-.0039	.0026	-.00033	.00022
00	0	.1871	.1882	-.0029	.0038	-.00024	.00032
00	0	.2123	.1793	-.0029	.0038	-.00024	.00032
6500	129	.2130	.1964	-.0027	.0067	-.00023	.00056
11700	232	.2121	.1957	-.0018	.0074	-.00015	.00062
15000	298	.2117	.1951	-.0014	.0080	-.00012	.00067

16 Con'td.

Applied Loads in Pounds		Extensometer Readings		Deformations Inches		Deformations Per Inch	
Total	Per. Sq. In.	Upper	Lower	Upper	Lower	Upper	Lower
15000	298	.2180	.1953	-.0014	.0080	-.00012	.00067
8500	169	.2185	.1960	-.0009	0093	-.00008	.00078
00	0	.2195	.1973	+.0006	.0100	+.00005	.00083
00	0	.2275	.2068	.0006	.0100	+.00005	.00083
6000	119	.2270	.2058	.0011	.0110	.00009	.00092
11800	233	.2265	.2050	.0016	.0118	.00014	.00099
17800	354	.2255	.2040	.0026	.0128	.00022	.00107
17800	354	.2092	.1947	.0026	.0128	.00022	.00107
8700	173	.2102	.1954	.0016	.0121	.00014	.00101
00	0	.2212	.1972	.0006	.0103	.00005	.00086
00	0	.2260	.2023	.0006	.0103	.00005	.00086
10000	199	.2250	.2015	.0016	.0111	.00014	.00093
17600	350	.2240	.1995	.0026	.0131	.00022	.00108
21000	417	.2230	.1989	.0036	.0137	.00030	.00114
21000	417	.2030	.1600	.0036	.0137	.00030	.00114
00	0	.2030	.1670	.0036	.0067	.00030	.00056
00	0	.2080	.1952	.0036	.0067	.00030	.00056
7900	157	.2070	.1940	.0046	.0089	.00038	.00074
17300	344	.2058	.1927	.0058	.0092	.00048	.00077
25000	497	.2040	.1910	.0076	.0109	.00063	.00091
25000	497	.1960	.1791	.0076	.0109	.00063	.00091
15800	314	.1970	.1799	.0066	.0101	.00055	.00084
00	0	.1995	.1830	.0051	.0062	.00043	.00052
00	0	.2377	.2085	.0051	.0062	.00043	.00052
14700	292	.2355	.2055	.0073	.0090	.00061	.00075
23800	473	.2340	.2043	.0088	.0104	.00073	.00087
28000	556	.2329	.2030	.0099	.0117	.00083	.00098

16 Con'td.

Applied Load in Pounds.		Extensometer Readings		Deformations Inches		Deformations Per Inch	
Total	Per. Sq. In.	Upper	Upper	Upper	Lower	Upper	Lower
28000	556	.2095	.2091	.0099	.0117	.00083	.00098
17800	354	.2106	.2097	.0088	.0111	.00073	.00093
00	0	.2140	.2130	.0044	.0068	.00037	.00057
00	0	.2040	.2050	.0044	.0068	.00037	.00057
10350	206	.2030	.2030	.0060	.0090	.00050	.00085
20500	408	.2010	.2010	.0080	.0110	.00067	.00092
27600	549	.2000	.2002	.0090	.0116	.00075	.00097
31000	616	.1982	.1982	.0108	.0136	.00090	.00115
31000	616	.2147	.2047	.0108	.0136	.00090	.00115
24200	481	.2152	.2050	.0101	.0133	.00084	.00111
12500	248	.2170	.2060	.0085	.0123	.00071	.00103
00	0	.2200	.2100	.0055	.0083	.00046	.00069
00	0	.2073	.1985	.0055	.0083	.00046	.00069
12800	255	.2045	.1955	.0083	.0113	.00069	.00097
23800	473	.2025	.1940	.0103	.0128	.00086	.00107
30300	604	.2010	.1925	.0123	.0143	.00101	.00118
33000	656	.1995	.1905	.0133	.0163	.00111	.00136
33000	656	.1990	.1770	.0133	0163	.00111	.00136
22100	440	.2000	.1773	.0123	.0160	.00101	.00133
11000	219	.2020	.1790	.0103	.0140	.00087	.00117
00	0	.2050	.1832	.0073	.0101	.00061	.00084
00	0	.1998	.2064	.0073	.0101	.00061	.00084
12000	239	.1970	.2020	.0101	.0145	.00084	.00121
24600	290	.1945	.2000	.0126	.0165	.00105	.00138
33500	676	.1920	.1980	.0151	.0185	.00134	.00154
37500	746	.1890	.1950	.0181	.0215	.00151	.00179

16 Con'td.

Applied Load in Pounds		Extensometer Readings		Deformations Inches		Deformation Per Inch	
Total	Per. Sq. In.	Upper	Lower	Upper	Lower	Upper	Lower.
37500	746	.1890	.2004	.0181	.0215	.00151	.00179
28700	570	.1895	.2005	.0176	.0214	.00147	.00179
12800	255	.1920	.2020	.0151	.0199	.00134	.00166
00	0	.1967	.2070	.0104	.0149	.00087	.00124
00	0	.1975	.2303	.0104	.0149	.00087	.00124
18200	362	.1930	.2255	.0149	.0197	.00124	.00164
28500	566	.1905	.2240	.0174	.0212	.00145	.00177
36000	716	.1885	.2215	.0194	.0237	.00162	.00199
42000	834	.1710	.2040	.0269	.0312	.00224	.00260
42000	834	Max.					

SPECIMEN 18.

Applied Loads in Pounds		Extensometer Readings		Deformations in Inches		Deformations Per Inch	
Total	Per Sq. In.	Upper	Lower	Upper	Lower	Upper	Lower
0000	00	.3600	.0292	0000	0000	00000	00000
4300	86	.3598	.0288	.0002	.0004	.00002	.00003
4300	86	.3700	.0239	.0002	.0004	.00002	.00003
0000	00	.3702	.0242	.0000	.0001	.00000	.00001
0000	00	.3955	.0251	.0000	.0001	.00000	.00001
4500	90	.3951	.0246	.0004	.0006	.00003	.00005
10400	207	.3948	.0237	.0007	.0015	.00006	.00013
10400	207	.4102	.0220	.0007	.0015	.00006	.00013
5000	99	.4105	.0223	.0004	.0012	.00003	.00010
0000	00	.4108	.0231	.0001	.0004	.00001	.00003
0000	00	.4150	.0391	.0001	.0004	.00001	.00003
4800	96	.4147	.0386	.0004	.0009	.00003	.00008
8800	175	.4145	.0381	.0006	.0014	.00005	.00012
12500	249	.4140	.0375	.0011	.0020	.00009	.00017
12500	249	.3921	.0330	.0011	.0020	.00009	.00017
7800	155	.3925	.0332	.0007	.0018	.00006	.00015
0000	00	.3929	.0335	.0003	.0015	.00003	.00013
0000	00	.3880	.0565	.0003	.0015	.00003	.00013
7400	147	.3878	.0562	.0005	.0018	.00004	.00015
11800	235	.3875	.0559	.0008	.0021	.00007	.00018
15500	308	.3873	.0553	.0010	.0027	.00008	.00023
15500	308	.3870	.0428	.0010	.0027	.00008	.00023
10500	209	.3875	.0430	.0005	.0025	.00004	.00021
5900	111	.3880	.0437	.0000	.0018	.00000	.00015
0000	00	.3883	.0445	-.0003	.0010	-.00003	.00008

SPECIMEN 18.

Applied Loads in Pounds		Extensometer Readings		Deformations Inches		Deformations Per Inch.	
Total	Per Sq. In.	Upper	Lower	Upper	Lower	Upper	Lower
0000	00	.4007	.0400	-.0003	.0010	-.00003	.00008
7000	139	.4001	.0394	.0003	.0016	.00003	.00013
12500	249	.3995	.0387	.0009	.0023	.00008	.00019
18000	358	.3990	.0380	.0014	.0030	.00012	.00025
18000	358	.3709	.0321	.0014	.0030	.00012	.00025
12400	247	.3714	.0323	.0009	.0028	.00008	.00023
7000	139	.3720	.0330	.0003	.0021	.00003	.00018
0000	00	.3727	.0341	-.0004	.0010	-.00003	.00008
0000	00	.3860	.0493	-.0004	.0010	-.00003	.00008
7000	139	.3853	.0483	.0003	.0020	.00003	.00017
14000	278	.3849	.0477	.0009	.0024	.00008	.00020
21000	402	.3840	.0470	.0018	.0031	.00015	.00026
21000	402	.3822	.0320	.0018	.0031	.00015	.00026
13800	274	.3829	.0323	.0011	.0028	.00009	.00023
7300	145	.3839	.0330	.0001	.0021	.00001	.00018
0000	00	.3843	.0342	-.0003	.0009	-.00003	.00008
0000	00	.3911	.0530	-.0003	.0009	-.00003	.00008
5700	107	.3906	.0522	.0002	.0017	.00002	.00014
11800	235	.3900	.0514	.0008	.0025	.00007	.00021
16800	334	.3892	.0509	.0016	.0030	.00013	.00025
24100	479	.3880	.0500	.0028	.0039	.00023	.00033
24100	479	.3837	.0389	.0028	.0039	.00023	.00033
15700	312	.3845	.0392	.0020	.0036	.00017	.00030
7800	155	.3855	.0402	.0010	.0026	.00008	.00022
0000	00	.3864	.0415	.0001	.0013	.00001	.00011

SPECIMEN 18

Applied Loads Pounds		Extensometer Readings		Deformations Inches		Deformations Per Inch	
Total	Per Sq. In.	Upper	Lower	Upper	Lower	Upper	Lower
0000	00	.3735	.0481	.0001	.0013	.00001	.00011
7200	143	.3729	.0475	.0007	.0019	.00006	.00016
14300	285	.3722	.0464	.0014	.0030	.00012	.00025
22500	447	.3715	.0455	.0021	.0039	.00018	.00031
27200	541	.3705	.0449	.0031	.0045	.00026	.00038
27200	541	.3885	.0209	.0031	.0045	.00026	.00038
16800	334	.3898	.0214	.0018	.0040	.00015	.00033
8900	175	.3906	.0223	.0010	.0031	.00008	.00026
0000	00	.3920	.0241	-.0004	.0013	-.00003	.00011
0000	00	.3780	.0250	-.0004	.0013	-.00003	.00011
10200	203	.3770	.0235	.0006	.0028	.00005	.00023
21000	402	.3763	.0222	.0013	.0041	.00011	.00034
30000	597	.3750	.0211	.0026	.0052	.00022	.00043
30000	597	.3878	.0484	.0026	.0052	.00022	.00043
20900	400	.3889	.0489	.0015	.0047	.00013	.00039
10500	209	.3900	.0500	.0004	.0036	.00003	.00030
0000	00	.3915	.0520	-.0011	.0016	-.00009	.00013
0000	00	.3853	.0250	-.0011	.0016	-.00009	.00013
8300	165	.3846	.0239	-.0004	.0027	-.00003	.00023
16600	330	.3832	.0228	.0010	.0038	.00008	.00032
25300	503	.3821	.0219	.0021	.0047	.00018	.00039
30400	605	.3815	.0210	.0027	.0056	.00023	.00047
33100	659	.3809	.0208	.0033	.0058	.00028	.00048
33100	659	.3825	.0265	.0033	.0058	.00028	.00048
25100	500	.3832	.0269	.0026	.0054	.00022	.00045
13800	274	.3848	.0280	.0010	.0043	.00008	.00036
0000	00	.3870	.0309	-.0012	.0014	-.00010	.00012

SPECIMEN 18.

Applied Loads Pounds		Extensometer Readings		Deformations Inches		Deformations Per Inch	
Total	Per Sq. In.	Upper	Lower	Upper	Lower	Upper	Lower
0000	00	.3805	.0373	-.0012	.0014	-.00010	.00012
9200	183	.3791	.0359	.0002	.0028	.00002	.00023
18200	362	.3781	.0345	.0012	.0042	.00010	.00035
27000	537	.3770	.0338	.0023	.0049	.00019	.00041
32500	647	.3760	.0331	.0033	.0056	.00028	.00047
36100	720	.3751	.0325	.0042	.0062	.00035	.00052
36100	720	.3831	.0217	.0042	.0062	.00035	.00052
23700	472	.3842	.0222	.0031	.0057	.00026	.00048
13900	277	.3859	.0233	.0014	.0046	.00012	.00038
0000	00	.3880	.0261	-.0007	.0018	-.00006	.00015
0000	00	.3912	.0489	-.0007	.0018	-.00006	.00015
9800	195	.3897	.0471	.0008	.0036	.00007	.00030
20000	398	.3881	.0455	.0024	.0052	.00020	.00043
30000	597	.3865	.0445	.0040	.0062	.00033	.00052
35600	709	.3856	.0440	.0049	.0067	.00041	.00056
38750	771	.3850	.0432	.0055	.0075	.00046	.00063
38750	771	.3895	.0439	.0055	.0075	.00046	.00063
29500	587	.3901	.0441	.0049	.0073	.00041	.00061
16200	322	.3919	.0453	.0031	.0061	.00026	.00051
0000	00	.3951	.0489	-.0001	.0025	-.00001	.00021
0000	00	.3730	.0165	-.0001	.0025	-.00001	.00021
10200	203	.3715	.0147	.0014	.0043	.00012	.00036
20200	402	.3695	.0132	.0034	.0058	.00028	.00048
30700	611	.3680	.0120	.0049	.0070	.00041	.00058
37400	744	.3670	.0112	.0059	.0078	.00049	.00065
40600	808	.3660	.0105	.0069	.0085	.00058	.00071
43000	855	.3650	.0096	.0079	.0094	.00066	.00078

SPECIMEN 18

Applied Loads Pounds		Extensometer Readings		Deformations Inches		Deformations Per Inch	
Total	Per Sq. In	Upper	Lower	Upper	Lower	Upper	Lower
43000	855	.3691	.0310	.0079	.0094	.00066	.00078
32000	637	.3700	.0313	.0070	.0091	.00058	.00076
15000	298	.3720	.0330	.0050	.0074	.00042	.00062
0000	00	.3760	.0370	.0010	.0034	.00008	.00028
0000	00	.3879	.0383	.0010	.0034	.00008	.00028
13400	267	.3850	.0368	.0039	.0049	.00033	.00041
27000	539	.3825	.0340	.0064	.0077	.00053	.00064
35000	697	.3815	.0330	.0074	.0087	.00062	.00073
41000	816	.3805	.0320	.0084	.0097	.00070	.00081
44000	876	.3795	.0310	.0094	.0107	.00078	.00089
47000	935	.3755	.0270	.0134	.0147	.00112	.00123
47000	935	.3825	.0309	.0134	.0147	.00112	.00123
39000	776	.3829	.0309	.0130	.0147	.00108	.00123
25000	498	.3845	.0320	.0114	.0136	.00095	.00113
13000	259	.3865	.0335	.0094	.0121	.00078	.00101
0000	00	.3910	.0379	.0049	.0077	.00041	.00064
0000	00	.3862	.0505	.0049	.0077	.00041	.00064
15100	300	.3826	.0470	.0085	.0112	.00071	.00093
25000	498	.3795	.0455	.0116	.0127	.00097	.00106
35000	697	.3780	.0440	.0131	.0142	.00109	.00118
42100	838	.3765	.0430	.0146	.0152	.00122	.00127
46250	920	.3755	.0415	.0156	.0167	.00130	.00139
51000	1015	.3690	.0340	.0221	.0192	.00184	.00160

SPECIMEN-20

Applied Load in Pounds		Extensometer Readings		Deformations Inches		Deformation Per Inch	
Total	Per Sq. In.	Lower	Upper	Lower	Upper	Lower	Upper
00	0	.0811	.0461	.0000	.0000	.00000	.00000
2250	45	.0809	.0450	.0002	.0011	.00002	.00009
4500	89	.0809	.0435	.0002	.0026	.00002	.00022
6650	132	.0807	.0430	.0004	.0031	.00003	.00026
9000	178	.0805	.0422	.0006	.0039	.00005	.00033
11500	227	.0803	.0363	.0008	.0097	.00007	.00081
13600	269	.0801	.0353	.0010	.0108	.00008	.00090
15900	315	.0798	.0340	.0013	.0121	.00011	.00101
17800	352	.0795	.0330	.0016	.0131	.00014	.00109
19700	390	.0790	.0315	.0021	.0146	.00018	.00122
21900	433	.0785	.0285	.0026	.0176	.00022	.00147
23600	467	.0780	.0265	.0031	.0196	.00026	.00163
26400	522	.0778	.0220	.0033	.0241	.00028	.00208
27700	548	.0755	.0185	.0056	.0276	.00047	.00230
29300	579	.0730	.0130	.0081	.0331	.00068	.00277
30500	603	.0710	.0085	.0101	.0376	.00084	.00314
31800	639	.0670	.0015	.0141	.0446	.00118	.00372
33000	653	.0600	-.0080	.0211	.0541	.00176	.00451
34000	675	Max.					

SPECIMEN 21.

Applied Loads Pounds		Extensometer Readings		Deformations Inches		Deformations Per Inch	
Total	Per Sq. In.	Upper	Lower	Upper	Lower	Upper	Lower
0000	00	.0618	.2989	.0000	.0000	.00000	.00000
2000	40	.0616	.2989	.0002	.0000	.00002	.00000
4350	87	.0612	.2985	.0006	.0004	.00005	.00003
6800	135	.0598	.2981	.0020	.0008	.00017	.00007
9500	189	.0591	.2977	.0027	.0012	.00023	.00010
9300	185	.0580	.2976	.0038	.0013	.00032	.00011
12250	244	.0575	.2970	.0043	.0019	.00038	.00016
14500	288	.0569	.2965	.0049	.0024	.00041	.00020
16600	330	.0563	.2962	.0055	.0027	.00046	.00023
18750	373	.0551	.2958	.0067	.0031	.00056	.00026
20850	415	.0548	.2950	.0070	.0039	.00058	.00033
22800	454	.0538	.2941	.0080	.0048	.00067	.00040
24800	494	.0533	.2931	.0085	.0058	.00071	.00048
27800	554	.0512	.2910	.0106	.0079	.00088	.00066
29300	584	.0504	.2900	.0114	.0089	.00095	.00074
31200	621	.0490	.2880	.0128	.0109	.00107	.00091
32500	646	.0478	.2860	.0140	.0129	.00117	.00108
33850	674	.0455	.2840	.0163	.0149	.00138	.00124
35500	706	.0450	.2820	.0168	.0169	.00140	.00141
37000	736	.0430	.2780	.0188	.0209	.00157	.00174
38300	763	.0405	.2750	.0213	.0239	.00178	.00199
39700	790	.0360	.2650	.0358	.0339	.00298	.00283
40800	812						

SPECIMEN 23

Applied Loads in Pounds		Extensometer Readings		Deformations Inches		Deformations Per Inch.	
Total	Per. Sq. In.	Upper	Lower	Upper	Lower	Upper	Lower
0000	00	.3035	.3332	.0000	.0000	.00000	.00000
1550	31	.3033	.3330	.0002	.0002	.00002	.00002
3150	62	.3031	.3328	.0004	.0004	.00003	.00003
4300	85	.3031	.3327	.0004	.0005	.00003	.00004
6300	124	.3030	.3325	.0005	.0007	.00004	.00006
7600	150	.3028	.3322	.0007	.0010	.00006	.00008
8600	170	.3027	.3320	.0008	.0012	.00007	.00010
11800	233	.3025	.3314	.0010	.0018	.00008	.00015
13700	271	.3023	.3305	.0012	.0027	.00010	.00023
15500	307	.3021	.3299	.0014	.0033	.00012	.00028
18000	356	.3018	.3290	.0017	.0042	.00014	.00035
19500	386	.3014	.3280	.0021	.0052	.00018	.00043
21700	429	.3010	.3260	.0025	.0072	.00021	.00060
24000	475	.2998	.3238	.0037	.0094	.00031	.00078
24700	491	.2950	.3208	.0085	.0124	.00071	.00103
26000	514	.2930	.3202	.0105	.0130	.00088	.00108
27000	534	.2901	.3186	.0134	.0136	.00101	.00113
27500	547	Max.					

SPECIMEN-24

Applied Loads in Pounds		Extensometer Readings		Deformations Inches		Deformations Per Inch	
Total	Per Sq. In.	Upper	Lower	Upper	Lower	Upper	Lower
00	0	.3400	.3706	.0000	.0000	.00000	.00000
2200	44	.3397	.3704	.0003	.0002	.00004	.00002
4400	87	.3390	.3704	.0010	.0002	.00008	.00002
6000	119	.3385	.3703	.0015	.0003	.00014	.00003
8200	162	.3380	.3701	.0020	.0005	.00017	.00004
9800	194	.3377	.3701	.0023	.0005	.00019	.00004
11600	229	.3376	.3701	.0024	.0005	.00020	.00004
13300	265	.3369	.3700	.0031	.0006	.00026	.00005
15200	301	.3365	.3700	.0035	.0006	.00028	.00005
17000	336	.3600	.3700	.0040	.0006	.00033	.00005
19000	376	.3352	.3700	.0048	.0006	.00040	.00005
21200	419	.3332	.3704	.0068	.0002	.00057	.00002
22900	453	.3322	.3705	.0078	.0001	.00065	.00001
24500	485	.3301	.3707	.0090	-.0001	.00075	-.00001
25900	512	.3292	.3709	.0108	-.0003	.00090	-.00003
27200	538	.3275	.3710	.0125	-.0004	.00104	-.00004
27800	550	.3252	.3714	.0148	-.0008	.00123	-.00007
28000	574	.3240	.3718	.0160	-.0012	.00133	-.00010
30000	594	.3215	.3720	.0185	-.0014	.00154	-.00012
31200	616	.3172	.3727	.0228	-.0021	.00190	-.00018
32300	640	.3113	.3740	.0287	-.0034	.00239	-.00028
33300	659	.3000	.3761	.0400	-.0056	.00333	-.00047
34500	686	Max.					

SPECIMEN 25.

Applied Loads Pounds		Extensometer Readings		Deformations Inches		Deformations Per Inch	
Total	Per Sq. In.	No. II	No. 2	No. II	No. 2	No. II	No. 2
850	1890	.3215	.3155	.0000	.0000	.00000	.00000
2600	5780	.3243	.3170	.0028	.0015	.00020	.00008
3500	7780	.3240	.3197	.0025	.0042	.00014	.00024
5000	11110	.3235	.3237	.0020	.0082	.00011	.00046
6600	14670	.3242	.3271	.0027	.0116	.00015	.00065
8000	17780	.3258	.3295	.0043	.0140	.00024	.00078
9750	21670	.3278	.3318	.0063	.0163	.00035	.00091
11000	24440	.3296	.3337	.0081	.0182	.00045	.00102
13200	29330	.3321	.3367	.0106	.0212	.00059	.00118
14950	32220	.3339	.3382	.0124	.0227	.00069	.00127
16100	35780	.3358	.3400	.0143	.0245	.00080	.00137
17550	39000	.3375	.3416	.0160	.0261	.00090	.00146
19100	42440	.3400	.3421	.0185	.0266	.00103	.00149
21250	47220	.3428	.3436	.0213	.0281	.00119	.00157
23450	52110	.3447	.3432	.0232	.0277	.00130	.00155
23500	52220	.3498	.3400	.0283	.0245	.00158	.00137
23500	52220	.3865	.3600	.0650	.0445	.00364	.00249

SPECIMEN-26.

Applied Load in Pounds		Extensometer Readings		Deformations Inches		Deformations Per Inch	
Total	Sq. In.	No 2	No II	No 2	No II	No 2	No II
150	330	.3448	.3105	.0000	.0000	.00000	.00000
1100	2445	.3465	.3099	.0017	-.0006	.00009	-.00003
1900	4225	.3480	.3107	.0032	+.0001	.00018	+.00001
3100	6890	.3505	.3115	.0057	.0010	.00032	.00006
4100	9150	.3515	.3130	.0067	.0025	.00037	.00014
5000	11100	.3528	.3140	.0080	.0035	.00045	.00020
6100	13550	.3538	.3160	.0090	.0055	.00050	.00031
7000	15550	.3545	.3170	.0097	.0065	.00054	.00036
8100	18000	.3558	.3190	.0110	.0085	.00062	.00048
9000	20000	.3570	.3204	.0122	.0099	.00068	.00055
10100	22450	.3587	.3215	.0139	.0110	.00078	.00062
11200	24900	.3600	.3220	.0152	.0115	.00085	.00064
12400	27550	.3613	.3227	.0165	.0122	.00092	.00068
13500	30000	.3630	.3243	.0182	.0138	.00102	.00077
14800	32900	.3645	.3255	.0197	.0150	.00110	.00084
16300	36220	.3662	.3270	.0214	.0165	.00119	.00092
17200	38220	.3672	.3278	.0224	.0173	.00125	.00097
18400	40900	.3685	.3284	.0237	.0179	.00132	.00100
19400	43100	.3700	.3288	.0252	.0183	.00141	.00102
20500	45600	.3714	.3291	.0266	.0186	.00148	.00104
21800	48450	.3733	.3288	.0285	.0183	.00159	.00102
22350	49700	.3747	.3281	.0299	.0176	.00167	.00098
23350	50950	.3762	.3278	.0314	.0173	.00175	.00097
23500	51120	4150	3580	.0702	.0475	.00400	.00265
38500	85580	Max.					

SPECIMEN - 27.

Applied Load in Pounds		Extensometer Readings		Deformations Inches		Deformations Per. Inch	
Total	Per. Sq. In.	Upper	Lower	Upper	Lower	Upper	Lower
00	00	.1159	.2848	.0000	.0000	.00000	.00000
2020	4490	Extensometer did not work, due to tight bearings.	.2672		.0024		.00014
2870	6380		.2875		.0027		.00016
3850	8560		.2885		.0037		.00021
4900	10880		.2891		.0043		.00025
6400	14220		.2913		.0065		.00037
7250	16110		.2929		.0081		.00045
8300	18450		.2944		.0096		.00056
9350	20790		.2961		.0113		.00065
10700	23780		.2845	cogs slipped	.0097		.00056
11650	25900		.2851		.0103		.00059
12530	27850		.2849	cogs Slipped	.0001		.00001
13600	30240		.2854		.0006		.00003
14550	32350		.2826	cogs slipped	-.0022		-.00013
16100	35800		.2835		-.0013		-.00007
17150	38100		.2841		-.0007		-.00004
18230	40300		.2850		+.0002		+.00001
19000	42220		.2864		.0016		.00009
21150	47000		.2890		.0042		.00024
22800	50300		.2896		.0048		.00028
22850	50400		.2905		.0057		.00033
38400	85350	Max.					

SPECIMEN 28.

Applied Loads Pounds		Extensometer Readings.		Deformations Inches		Deformations Per Inch	
Total	Per Sq. In	No. 2	No. II	No. 2	No. II	No. 2	No. II
350	770	.4150	.4082	.0000	.0000	.00000	.00000
1000	2220	.4185	.4072	.0035	-.0010	.00019	-.00006
2500	5560	.4198	.4091	.0048	.0009	.00027	.00005
4100	9110	.4215	.4120	.0065	.0038	.00036	.00021
5500	12220	.4230	.4142	.0080	.0060	.00044	.00025
6500	14440	.4240	.4158	.0090	.0076	.00045	.00042
8200	18220	.4260	.4185	.0110	.0103	.00061	.00056
9550	21220	.4280	.4205	.0130	.0123	.00072	.00068
10750	23890	.4310	.4203	.0160	.0121	.00088	.00067
12000	26670	.4332	.4205	.0182	.0123	.00101	.00068
12650	28110	.4360	.4195	.0210	.0113	.00116	.00062
12800	28440	.4355	.4205	.0205	.0123	.00113	.00068
13350	29670	.4410	.4230	.0260	.0148	.00144	.00082
13500	30000	.4820	.4500	.0670	.0418	.00375	.00231
14530	32290	.5910	.5400	.0760	.1318	.00420	.00738
15300	34000						

SPECIMEN-30

Applied Load in Pounds		Extensometer Readings		Deformations Inches		Deformations Per Inch	
Total	Per Sq. In.	No 2	No II	No 2	No II	No 2	No II
250	553	.4088	.3719	.0000	.0000	.00000	.00000
1100	2440	.4060	.3730	-.0028	.0011	.00015	.00006
2000	4450	.4050	.3750	-.0038	.0031	-.00021	.00016
3000	6650	.4109	.3709	+.0021	-.0010	+.00011	-.00005
4000	8880	.4152	.3685	.0064	-.0066	+.00035	-.00036
5000	11100	.4175	.3689	.0087	-.0070	.00048	-.00038
6500	14450	.4203	.3695	.0116	-.0086	.00063	-.00047
8000	17750	.4239	.3705	.0151	-.0014	.00082	-.00008
9500	21100	.4284	.3700	.0196	-.0019	.00106	-.00010
10400	23100	.4330	.3700	.0242	-.0019	.00131	-.00010
12000	26700	.4375	.3700	.0287	-.0019	.00156	-.00010
13200	29350	.4373	.3843	.0285	+.0124	.00155	+.00067
13300	29550	.4350	.3913	.0272	.0194	.00148	.00105
13600	32100	.4580	.4280	.0492	.0561	.00267	.00330
Reset Extensometers at 0 Load.							
00	00	.3905	.4190	.0000	.0000	.00000	.00000
9450	21000	.4050	.4290	.0145	.0100	.00079	.00054
13200	29350	.4200	.4480	.0295	.0290	.00160	.00157
13500	30000	.4370	.4703	.0465	.0513	.00252	.00278
20600	45800	Max.					

SPECIMEN 35.

Applied Loads Pounds		Extensometer Readings.		Deformations Inches		Deformations Per Inch	
Total	Per Sq. In.	Upper	Lower	Upper	Lower	Upper	Lower
650	13	.4388	.4623	.0000	.0000	.00000	.00000
6600	131	.4381	.4621	.0007	.0002	.00006	.00002
11850	236	.4379	.4619	.0009	.0004	.00008	.00003
18100	300	.4373	.4614	.0015	.0009	.00013	.00008
22800	454	.4369	.4609	.0019	.0014	.00016	.00012
27000	537	.4367	.4608	.0021	.0015	.00018	.00013
30000	597	.4362	.4605	.0026	.0018	.00022	.00015
32750	652	.4360	.4603	.0028	.0020	.00023	.00017
34000	677	.4358	.4602	.0030	.0021	.00025	.00018
36400	724	.4355	.4600	.0033	.0023	.00028	.00019
39000	776	.4353	.4599	.0035	.0024	.00029	.00020
41500	826	.4350	.4598	.0038	.0025	.00032	.00021
44850	893	.4348	.4595	.0040	.0028	.00033	.00023
47900	953	.4344	.4593	.0044	.0030	.00037	.00025
51700	1029	.4341	.4591	.0047	.0032	.00039	.00027
55900	1112	.4337	.4589	.0051	.0034	.00043	.00028
60800	1212	.4330	.4586	.0058	.0037	.00048	.00031
65300	1300	.4324	.4581	.0064	.0042	.00053	.00035
69400	1381	.4319	.4579	.0069	.0044	.00058	.00037
73200	1457	.4311	.4573	.0077	.0050	.00064	.00042
78000	1552	.4304	.4569	.0084	.0054	.00070	.00045
81700	1626	.4298	.4565	.0090	.0058	.00075	.00048
86150	1714	.4290	.4561	.0098	.0062	.00082	.00052
89850	1788	.4280	.4558	.0108	.0065	.00090	.00054
94600	1883	.4270	.4554	.0118	.0069	.00098	.00058
97950	1949	.4260	.4549	.0128	.0074	.00107	.00062
100550	2001	.4251	.4547	.0137	.0076	.00114	.00063

SPECIMEN 35

Applied Loads Pounds		Extensometer Readings		Deformations Inches		Deformations Per Inch	
Total	Per Sq. In.	Upper	Lower	Upper	Lower	Upper	Lower
100550	2001	.3840	.3842	.0137	.0076	.00114	.00063
93000	1851	.3841	.3843	.0136	.0075	.00113	.00063
75000	1493	.3851	.3850	.0126	.0068	.00105	.00057
50000	995	.3871	.3860	.0106	.0058	.00088	.00048
24000	476	.3875	.3895	.0102	.0023	.00085	.00019
0000	000	.3929	.3918	.0048	.0000	.00040	.00000
0000	000	.4740	.4759	.0048	.0000	.00040	.00000
10100	201	.4737	.4750	.0051	.0009	.00043	.00008
23000	456	.4731	.4738	.0057	.0021	.00048	.00018
51800	1031	.4691	.4718	.0097	.0041	.00081	.00034
74600	1485	.4670	.4708	.0118	.0051	.00098	.00043
90800	1805	.4652	.4699	.0136	.0060	.00113	.00050
100000	1990	.4640	.4690	.0148	.0069	.00123	.00058
100000	1990	.3911	.4729	.0148	.0069	.00123	.00058
93600	1883	.3912	.4730	.0147	.0068	.00123	.00057
74300	1479	.3921	.4733	.0138	.0065	.00115	.00054
49500	985	.3942	.4746	.0117	.0053	.00098	.00043
23300	464	.3971	.4751	.0088	.0047	.00073	.00039
9000	177	.3990	.4779	.0069	.0019	.00058	.00016
0000	000	.4000	.4795	.0059	.0003	.00049	.00003
0000	000	.4812	.4835	.0059	.0003	.00049	.00003
14000	279	.4785	.4820	.0086	.0018	.00072	.00015
23000	458	.4775	.4810	.0096	.0028	.00080	.00023
50000	995	.4755	.4795	.0106	.0043	.00088	.00036
72000	1433	.4732	.4781	.0129	.0057	.00108	.00048
91700	1825	.4715	.4772	.0146	.0066	.00122	.00055
100500	2000	.4705	.4770	.0156	.0068	.00130	.00057

SPECIMEN 35.

Applied Loads Pounds.		Extensometer Readings		Deformations Inches		Deformations Per Inch	
Total	Per Sq. In.	Upper	Lower	Upper	Lower	Upper	Lower
100500	2000	.3878	.4185	.0156	.0068	.00130	.00057
92350	1838	.3880	.4186	.0154	.0067	.00128	.00056
74500	1483	.3891	.4191	.0143	.0062	.00119	.00052
51000	1015	.3908	.4200	.0126	.0053	.00105	.00044
25000	496	.3932	.4215	.0102	.0038	.00085	.00032
9600	191	.3955	.4231	.0079	.0022	.00066	.00018
0000	00	.3968	.4250	.0066	.0003	.00055	.00003

SPECIMEN-37

Applied Load in Pounds		Extensometer Readings		Deformations Inches		Deformations Per Inch	
Total	Per Sq.In.	No.2	No.II	No.2	No.II	No.2	No.II
500	00	.3698	.3717	.0000	.0000	.00000	.00000
1000	2220	.3695	.3730	-.0003	.0013	-.00003	.00012
2050	4550	.3645	.3800	-.0053	.0083	-.00049	.00077
3000	6630	.3615	.3842	-.0083	.0125	-.00080	.00115
4500	10000	.3585	.3891	-.0113	.0174	-.00104	.00161
6100	13550	.3601	.3904	-.0097	.0187	-.00089	.00173
7550	16770	.3623	.3905	-.0075	.0188	-.00069	.00174
9100	22200	.3642	.3910	-.0056	.0193	-.00052	.00178
10750	23900	.3663	.3917	-.0035	.0200	-.00032	.00184
12200	27100	.3680	.3927	-.0018	.0210	-.00017	.00194
13300	29550	.3691	.3932	-.0007	.0215	-.00006	.00197
15000	33330	.3710	.3942	+.0012	.0225	+.00011	.00207
16650	37000	.3727	.3952	.0029	.0235	.00027	.00217
17800	39550	.3747	.3960	.0049	.0243	.00045	.00224
18900	42000	.3751	.3960	.0063	.0243	.00058	.00224
20500	45550	.3770	.3960	.0082	.0243	.00075	.00224
22100	49100	.3790	.3972	.0092	.0255	.00085	.00235
22700	52500	.3785	.3990	.0087	.0273	.00080	.00253
23350	51670	.3790	.4000	.0092	.0283	.00085	.00261
23600	52420	.3820	.4050	.0122	.0333	.00112	.00307
23600	52420	.3890	.4195	.0192	.0478	.00177	.00441
23900	53100	.3990	.4195	.0292	.0488	.00269	.00450
24300	54000	.5400	.5300	.1702	.1593	.01567	.01446
25400	26420	.5700	.5600	.2002	.1883	.01844	.01736
38300	85070	Max.					

SPECIMEN 38

Applied Loads Pounds		Extensometer Readings.		Deformations Inches		Deformations Per Inch	
Total	Per Sq. In.	Ext. 2	Ext. II	Ext. 2	Ext. II	Ext. 2	Ext. II
240	530	.3358	.3579	.0000	.0000	.00000	.00000
1240	2760	.3310	.3583	-.0048	.0004	-.00048	.00004
2500	5560	.3300	.3609	-.0058	.0020	-.00058	.00020
3850	8560	.3295	.3632	-.0063	.0053	-.00063	.00053
5100	11330	.3292	.3655	-.0066	.0076	-.00066	.00076
6450	14330	.3291	.3673	-.0067	.0094	-.00067	.00094
7700	17110	.3292	.3688	-.0066	.0109	-.00066	.00109
9100	20220	.3293	.3701	-.0065	.0122	-.00065	.00122
10500	23330	.3294	.3712	-.0064	.0133	-.00064	.00133
11400	25330	.3292	.3719	-.0066	.0140	-.00066	.00140
12150	27000	.3291	.3723	-.0067	.0144	-.00067	.00144
13700	30440	.3303	.3730	-.0055	.0151	-.00055	.00151
14600	32440	.3312	.3730	-.0046	.0151	-.00046	.00151
15400	34110	.3321	.3730	-.0037	.0151	-.00037	.00151
16650	37000	.3344	.3723	-.0014	.0144	-.00014	.00144
18000	40000	.3373	.3711	.0015	.0132	.00015	.00132
19250	42780	.3400	.3700	.0042	.0121	.00042	.00121
20500	45560	.3423	.3682	.0065	.0103	.00065	.00103
21750	48330	.3425	.3680	.0067	.0101	.00067	.00101
22500	50000	.3412	.3698	.0054	.0119	.00054	.00119
23300	51780	.3392	.3715	.0034	.0136	.00034	.00136
23500	52220	.3422	.3745	.0064	.0166	.00064	.00166
23500	52220	.3900	.3600	.0542	.0021	.00542	.00021
24000	53330	.5125	.4400	.1767	.0821	.01767	.00821
24000	53330	.5425	.4800	.2067	.1221	.02067	.01221
38450	85440						

SPECIMEN 41.

Applied Loads Pounds		Extensometer Readings.		Deformations Inches		Deformations Per Inch	
Total	Per Sq. In	No. II	No. I	No. II	No. I	No. II	No. I
600	1330	.3638	.1740	.0000	.0000	.00000	.00000
1600	3560	.3748	.1670	.0110	-.0070	.00081	-.00039
3200	7110	.3803	.1652	.0165	-.0088	.00091	-.00049
5000	11110	.3853	.1652	.0215	-.0088	.00119	-.00049
6650	14780	.3885	.1665	.0247	-.0075	.00137	-.00042
10200	22670	.3943	.1694	.0305	-.0046	.00169	-.00026
12000	26670	.3975	.1715	.0337	-.0025	.00187	-.00014
13600	30220	.4000	.1740	.0362	.0000	.00201	-.00000
14700	32670	.4015	.1748	.0377	.0008	.00209	.00004
16000	35560	.4035	.1763	.0397	.0023	.00220	.00013
17500	38890	.4055	.1780	.0417	.0040	.00231	.00022
19050	42330	.4095	.1783	.0457	.0043	.00253	.00024
20500	45560	.4131	.1780	.0493	.0040	.00273	.00022
22100	49110	.4185	.1770	.0547	.0030	.00302	.00017
23000	51110	.4180	.1800	.0542	.0060	.00300	.00033
23500	52220	.4172	.1815	.0534	.0075	.00296	.00042
23750	52780	.4200	.1800	.0562	.0060	.00312	.00033
23700	52670	.4350	.1920	.0712	.0180	.00395	.00010
24100	53560	.4710	.2450	.1072	.0710	.00594	.00394
23600	52440	.5550	.3410	.1912	.1670	.01060	.00926
24000	53330	.5900	.3800	.2277	.2060	.01259	.01142
24500	54440	.6175	.4700	.2537	.2960	.01463	.01641
26000	57780	.7350	.5035	.3712	.3295	.02058	.01856
28000	62220	.8050	.6180	.4412	.4440	.02446	.02461
30200	67110	.9050	.7500	.5412	.5760	.03000	.03193
32000	71110	1.0050	.9000	.6412	.7260	.03554	.04024
38500	85560	Max. load.					

SPECIMEN-42.

Applied Load in Pounds		Extensometer Readings		Deformations Inches		Deformations Per Inch	
Total	Per. Sq. In.	No. 2	No II	No 2	No II	No 2	No II
100	220	.3614	.0856	.0000	.0000	.00000	.00000
1100	2400	.3632	.0861	.0018	.0005	.00010	.00003
2650	5890	.3663	.0872	.0049	.0012	.00027	.00007
4500	10000	.3703	.0885	.0089	.0029	.00048	.00016
6750	14900	.3753	.0898	.0139	.0042	.00075	.00023
9150	20330	.3803	.0906	.0199	.0050	.00108	.00027
10700	23780	.3854	.0915	.0231	.0059	.00125	.00032
12000	26680	.3868	.0923	.0254	.0067	.00137	.00036
13300	29550	.3883	.0931	.0269	.0075	.00146	.00041
15100	33550	.3915	.0942	.0301	.0086	.00162	.00046
16600	36900	.3946	.0945	.0332	.0089	.00179	.00048
17700	39330	.3963	.0947	.0349	.0091	.00189	.00049
19850	41000	.4015	.0945	.0401	.0089	.00217	.00048
20800	46230	.4040	.0940	.0426	.0084	.00230	.00045
22100	49100	.4050	.0950	.0436	.0094	.00236	.00050
23150	50650	.4040	.0995	.0426	.0139	.00230	.00075
23600	52256	.4045	.1000	.0431	.0144	.00233	.00078
23900	53050	.4030	.1015	.0416	.0159	.00225	.00086
23500	52100	.4050	.1020	.0436	.0164	.00236	.00128
23800	53040	.4085	.1065	.0471	.0209	.00255	.00138
24100	53280	.4205	.1350	.0591	.0394	.00320	.00173
24100	53280	.5150	.1850	.0536	.0994	.00290	.00556
24800	55050	.6720	.1980	.3106	.1124	.01678	.00560
26000	57680	.7100	.4580	.3486	.3724	.01884	.01061
27850	61680	.7900	.5065	.4286	.4209	.02314	.01250
30000	66660	.9200	.7000	.5586	.6144	.03063	.01656
38700	86000	Max.					

SPECIMEN 44.

Applied Loads in Pounds		Extensometer Readings		Deformations in Inches.		Deformations Per Inch.	
Total	Per Sq. In.	Upper	Lower	Upper	Lower	Upper.	Lower.
0000	00	.2950	.2909	.0000	.0000	.00000	.00000
2000	40	.2949	.2908	.0001	.0001	.00001	.00000
4000	79	.2948	.2903	.0002	.0006	.00002	.00005
6000	119	.2947	.2899	.0003	.0010	.00003	.00008
8000	159	.2947	.2895	.0003	.0014	.00003	.00012
10000	199	.2947	.2890	.0003	.0019	.00003	.00016
12100	240	.2945	.2885	.0005	.0024	.00004	.00020
14000	278	.2940	.2880	.0010	.0029	.00008	.00024
16000	318	.2940	.2875	.0010	.0034	.00008	.00028
18000	358	.2937	.2863	.0013	.0046	.00011	.00038
20500	408	.2935	.2859	.0015	.0050	.00013	.00042
22500	448	.2933	.2853	.0017	.0056	.00014	.00046
24000	478	.2931	.2849	.0019	.0060	.00016	.00050
26000	517	.2929	.2841	.0021	.0068	.00018	.00057
28000	557	.2923	.2832	.0027	.0077	.00023	.00064
30000	597	.2920	.2825	.0030	.0084	.00025	.00070
32000	637	.2914	.2818	.0036	.0091	.00030	.00076
34000	677	.2907	.2805	.0043	.0104	.00036	.00087
36500	726	.2900	.2797	.0050	.0112	.00042	.00093
38000	756	.2894	.2785	.0056	.0124	.00047	.00103
40000	796	.2881	.2780	.0069	.0129	.00058	.00108
42000	836	.2870	.2752	.0080	.0157	.00067	.00131
43300	862	.2858	.2735	.0092	.0174	.00077	.00145
44400	883	.2847	.2725	.0103	.0184	.00088	.00153
46000	915	.2832	.2705	.0118	.0204	.00098	.00170
47700.	948	.2804	.2677	.0146	.0232	.00122	.00193
47800	Max. 950	.2610	.2540	.0340	.0369	.00283	.00308

SPECIMEN 45.

Applied Load Pounds		Extensometer Readings		Deformations Inches		Deformations Per Inch	
Total	Per Sq. In	Upper	Lower	Upper	Lower	Upper	Lower
0000	00	.1290	.4641	.0000	.0000	.00000	.00000
1500	30	.1290	.4639	.0000	.0002	.00000	.00002
3500	70	.1288	.4637	.0002	.0004	.00002	.00003
5550	110	.1285	.4637	.0005	.0004	.00004	.00003
7500	149	.1282	.4637	.0008	.0004	.00007	.00003
9800	195	.1278	.4637	.0012	.0004	.00010	.00003
12000	238	.1273	.4635	.0017	.0006	.00014	.00005
14000	278	.1268	.4634	.0022	.0007	.00018	.00006
16000	318	.1263	.4633	.0027	.0008	.00023	.00007
18000	358	.1258	.4632	.0032	.0009	.00027	.00008
20600	410	.1250	.4630	.0040	.0011	.00033	.00009
22000	438	.1245	.4628	.0045	.0013	.00038	.00011
24700	486	.1235	.4625	.0055	.0016	.00046	.00013
26000	517	.1230	.4625	.0060	.0016	.00050	.00013
28300	563	.1221	.4619	.0069	.0022	.00058	.00018
30000	597	.1215	.4615	.0075	.0026	.00063	.00022
32000	637	.1203	.4610	.0087	.0031	.00073	.00026
34000	677	.1195	.4605	.0095	.0036	.00079	.00030
36000	717	.1182	.4600	.0108	.0041	.00090	.00034
38000	756	.1162	.4585	.0128	.0056	.00107	.00047
40000	796	.1142	.4570	.0148	.0071	.00123	.00059
42000	836	.1098	.4525	.0192	.0116	.00160	.00097
42000	Max.	load.					

SPECIMEN 46.

Applied Loads in Pounds		Extensometer Readings		Deformations Inches		Deformations Per Inch	
Total	Per Sq. In.	No. II	No. 2	No. II	No. 2	No. II	No. 2
800	1780	.3850	.3309	.0000	.0000	.00000	.00000
2000	4440	.3815	.3383	$.\bar{0}035$	.0074	$.\bar{0}0023$	.00048
3000	6670	.3770	.3442	$.\bar{0}080$	.0133	$.\bar{0}0052$	.00086
4650	10330	.3750	.3504	$.\bar{0}100$	.0195	$.\bar{0}0065$	.00094
6000	13330	.3748	.3542	$.\bar{0}102$	.0233	$.\bar{0}0066$	.00156
8000	17780	.3770	.3571	$.\bar{0}080$	.0282	$.\bar{0}0052$	.00182
10000	22220	.3795	.3595	$.\bar{0}055$	.0286	$.\bar{0}0035$	.00185
12200	27110	.3820	.3620	$.\bar{0}030$	.0311	$.\bar{0}0019$	.00201
13500	30000	.3845	.3635	$.\bar{0}005$	.0326	$.\bar{0}0003$	.00210
15600	34670	.3867	.3665	.0017	.0356	.00011	.00230
18000	40000	.3895	.3706	.0045	.0397	.00029	.00256
20000	44440	.3900	.3746	.0050	.0437	.00032	.00282
21500	47780	.3880	.3783	.0030	.0474	.00019	.00306
23000	51110	.3830	.3885	$.\bar{0}020$	.0576	$.\bar{0}0013$	.00372
23000	51110	.3950	.3810	.0100	.0501	.00065	.00323
23600	52440	.3955	.3875	.0105	.0566	.00068	.00365
23300	51780	.4050	.3950	.0200	.0641	.00129	.00414
23750	52780	.4550	.4770	.0700	.1461	.00452	.00943
24000	53330	.4900	.4920	.1050	.1611	.00677	.01039
26000	57780	.7000	.5155	.3150	.1841	.02032	.01188
29000	64450	.8440	.5400	.4590	.2091	.02961	.01349
30500	67780	.9460	.6230	.5610	.2921	.03619	.02335
32500	72220	1.1250	.7450	.7400	.4141	.04774	.02672
34000	75560	1.2960	.9400	.9110	.6091	.05877	.03930
35000	77780	1.5500	1.0150	1.1650	.6841	.07519	.04414
36000	80000	1.6670	1.0900	1.2820	.7591	.08271	.04897
37000	82220	2.0000	1.5340	1.6150	1.2031	.10419	.07762

SPECIMEN-47

Applied Load in Pounds		Extensometer Readings		Deformations Inches		Deformations Per Inch	
Total	Per. Sq. In.	No 2	No II	No 2	No II	No 2	No II
500	1130	.3748	.1842	.0000	.0000	.00000	.00000
1950	.4330	.3830	.1775	.0082	-.0067	.00069	-.00056
3000	6660	.3855	.1778	.0107	-.0064	.00089	-.00054
5100	11110	.3888	.1780	.0140	-.0062	.00117	-.00052
7200	16000	.3915	.1875	.0167	-.0057	.00140	-.00048
8500	18890	.3932	.1788	.0184	-.0054	.00154	-.00045
11000	24650	.3980	.1780	.0232	-.0062	.00195	-.00052
12000	26660	.3980	.1795	.0232	-.0057	.00195	-.00048
13000	28900	.4050	.1765	.0302	-.0077	.00253	-.00065
13000	28900	.4100	.1740	.0353	-.0102	.00295	-.00085
13100	29100	.4200	.1685	.0452	-.0157	.00279	-.00132
13200	29340	.4250	.1655	.0502	-.0187	.00422	-.00157
13350	29680	.4320	.1635	.0572	-.0207	.00481	-.00173
13500	30000	.4345	.1705	.0597	-.0137	.00500	-.00115
13600	30240	.4590	.1705	.0842	-.0137	.00705	-.00115
14500	32220	.5250	.1865	.1502	+.0023	.01258	+.00019
15000	33330	.7474	.5000	.3622	.3158	.03026	.02645
16000	35550	.9449	.6360	.5701	.4518	.04777	.03780
17000	37770	1.0850	.7770	.7102	.5968	.05925	.05000
18000	40000	1.3000	.9370	.9252	.7528	.07750	.06445
19000	42220	1.5080	1.0114	1.1332	.8272	.09500	.07960
20000	44440	2.0060	1.5180	1.6312	1.3238	.13650	.11440
20700	46220	Max.					

SPECIMEN-48.

Applied Load in Pounds		Extensometer Readings		Deformations Inches		Deformations Per Inch.	
Total	Per Sq.In.	No.2	No.II	No.2	No.II	No.2	No.II
400	890	.9913	.9945	.0000	.0000	.00000	.00000
2700	6000	.9835	.9993	.0078	-.0048	.00079	-.00049
4000	8890	.9790	1.0022	.0128	-.0077	.00124	-.00078
5550	12220	.9765	1.0030	.0158	-.0085	.00159	-.00086
6850	15120	.9750	1.0025	.0163	-.0080	.00164	-.00081
8750	19440	.9745	1.0018	.0168	-.0063	.00169	-.00064
10700	23770	.9725	1.0010	.0188	-.0065	.00189	-.00066
12000	26700	.9695	1.0010	.0208	-.0065	.00209	-.00066
14250	31700	.9670	1.0008	.0243	-.0063	.00244	-.00064
16100	35770	.9645	1.0000	.0268	-.0055	.00269	-.00056
17600	39120	.9630	.9994	.0283	-.0049	.00283	-.00050
18950	42000	.9625	.9986	.0288	-.0041	.00289	-.00042
20000	44500	.9610	.9980	.0303	-.0035	.00304	-.00036
21500	47800	.9620	.9950	.0293	-.0005	.00294	-.00005
22500	50000	.9600	.9960	.0313	-.0015	.00315	-.00016
23000	50550	.9492	1.0090	.0421	-.0045	.00423	-.00046
23450	52000	.9485	1.0060	.0428	-.0115	.00430	-.00116
23400	52000	.9340	1.0020	.0573	-.0075	.00575	-.00076
23200	51600	.9201	1.0020	.0712	-.0075	.00714	-.00076
23450	52000	.8820	.9420	.1093	+.0025	.01097	+.00026
24000	53160	.8430	.8910	.1483	.1035	.01490	.01040
25000	55550	.8285	.8880	.1628	.1145	.01635	.01150
26000	57800	.8060	.8570	.1853	.1375	.01863	.01380
32000	71170	.6250	.6270	.3663	.3675	.03670	.03690
36000	80000	.4120	.3820	.5793	.6125	.05825	.06130
38000	84400	.0900	.0300	.9013	.9645	.09660	.09660
38870	86400	Max.					

TABLE III.

SUMMARY OF PLAIN CONCRETE.

Specimen Number	Age at Test Days	Proportion of Cement Sand and Stone	Dimensions of Specimen	Application of Loads	Maximum Load Pounds Per Sq. In.	Coefficient of Elasticity				
						Initial Load	At 250 lb. Per Sq. In	At 500 lb. Per Sq. In.	At 1000 lb. Per Sq. In	At Beginning of Failure.
1	31✓	1:3:6	8"dia. 16"long	Continuous	820	2,050,000	1,340,000			
11	10✓	1:3:6	"	"	427	2,000,000	1,780,000			1,780,000
13	30✓	1:3:6	"	"	795	2,140,000	1,660,000	1,040,000		860,000
14	30✓	1:3:6	"	"	789	2,000000	1,192,000	735000		500,000
16	60✓	1:3:6	"	Repeated	834	3,120,000	1,560,000	680000		680,000
18	60✓	1:3:6	"	"	1015	3,150,000	2,227,000	1,850,000		1,220,000
20	30✓	1:3:6	"	Continuous	675	1,038000	760000			660000
21	60✓	1:3:6	"	"	810	1,600000	1,040,000	770000		770000
23	15✓	1:3:6	"	"	547	2,790000	1,920000			1,140000
24	15✓	1:3:6	"	"	686	1,820,000	1,850000	1,220000		
35	62	1:2:4	"	Repeated	2000+	3,140,000	3,140000	3,140000	3,140000	
44	15✓	1:3:6	"	Continuous	951	2,150000	1920000	1425000		1,130000
45	14✓	1:3:6	"	"	839	2,850,000	2,370,000	1605000		1,057,000

TABLE IV.

SUMMARY OF ENCASED-STEEL.

Specimen Number	Age at Test days	Proportions of Cement Sand and Stone	Dimensions of Specimen	Kinds of Steel Elastic Limit	Maximum Load Pounds Per Sq. In.	Coefficient of Elasticity.
25	61	1:3:6	8"dia., 16"long	¾"",51000	85350	33000000
26	61	1:3:6	" "	" "	85580	34400 000
28	61	1:3:6	" "	" 34000	46220	30 000 000
30	60	1:3:6	" "	" "	45800	×
37	60	1:3:6	8" " , 8" "	" 51000	85070	30600 000
38	60	1:3:6	" "	" "	86200	36700000
41	55	1:3:6	4" " , 16" "	" "	86300	30000000
42	55	1:3:6	" "	" "	86000	33100 000
46	Plain	Rod		" "	86250	27900000
47	"	"		" 34000	46220	36300 000
48	"	"		" 51000	86400	33600000

× Extensometer readings for 30 can not be relied upon.

Observations and Conclusions.

Plain Concrete in Compression.

In making the specimens for such tests as herein described, care is very necessary in mixing, tamping and testing. To secure the best results, therefore, six specimens can well be made at one time, looking ahead to testing two of these in a day.

The age of concrete, within ten to sixty days, makes no material difference in the value of the coefficient of elasticity of plain concrete.

The coefficient of elasticity of plain concrete in compression is approximately 2,000,000. The initial curve is parabolic.

Encased Steel.

The "high steel" had a polished surface; the other steel had a rough but not a rusty surface. No apparent difference in the results, however, were detected.

It is concluded that the encasement of a steel rod in concrete does not affect the coefficient of elasticity of the steel.